THURSDAY, MAY 15, 1879

THE VICTORIA UNIVERSITY

THE movement for founding a new university in the north of England has progressed considerably since the question was discussed in these columns in July, 1876. It has now shaped itself into a final memorial to the Privy Council, which will be presented to the Lord President by a peculiarly powerful deputation this very day. Let us hope that the reply will be a favourable one, believing as we do that the educational welfare of the country demands an increase in the number of its universities. It may be desirable to say a few words about the progress of this movement.

On July 20, 1877, a memorial addressed to the Privy Council was presented to the Lord President praying that Her Majesty should be advised to grant a charter to the Owens College, Manchester, to be thenceforth called the University of Manchester, with power to grant degrees in Arts, Science, Medicine, and Law.

A slight modification of the original programme has now been made with the view of providing more effectually for two of the objects contemplated in the former memorial, viz. (1) for an ample and sufficient control over the proposed university, as a national place of education and learning, by the Government of the country; and (2) for the incorporation in the proposed university, on equitable terms and on satisfactory conditions, of other colleges besides the Owens College. This is not the place in which to discuss in detail the constitution proposed. We may, however, remark that Owens College is to be named in the charter as the first college of the new university, and that Manchester is to be the local centre of this institution.

In consequence of this modification the support to the memorial will be, we believe, even more powerful than that formerly given and may be taken as fairly representing the opinion of two great counties in the north of England. The Lord President has consented to receive simultaneously two deputations, one headed by the Duke of Devonshire, president of the Owens College, and the other from the Yorkshire College, Leeds, headed by the Archbishop of York.

Since this scheme has been before the public the most persistent objection urged against it has been advanced by those who maintain that the teaching and examining functions of a university should be perfectly distinct. It may be worth while to discuss this objection from two points of view, endeavouring to ascertain in the first place what is the present practice in this country of the existing universities, and then to find what course is best in principle.

Let us begin with the London Examining Board, which has no teaching staff connected with it, and ask ourselves whether its machinery secures an absolute separation between the examining and teaching elements. There can only be a negative reply to this question. The Senate of the London Board frequently select examiners who are teachers in one of the two London colleges or in Owens College, Manchester; that is to say, in institutions which send numerous candidates to the London examinations.

The result of this system must inevitably be that (without any blame being attributable to any one) the pupils of such an examiner have an advantage over other candidates whose teachers are not so represented. Thus, with respect to this Central Board, only a partial separation between the teaching and examining elements has been found practicable, and a very questionable advantage has been given to certain candidates in the examinations.

Let us next take Cambridge, as representing one of the great English Universities. Here it is the practice that the Committees who arrange the branches of study for the various examinations should consist very largely of professors and lecturers, who likewise form a large portion of the examining body. Occasionally a private tutor is chosen as an examiner, in which case, for a few months preceding the examination, he is expected or required to give up those of his pupils who are coming forward as candidates.

Now, while this system is infinitely preferable to that of the London Board, yet even here the former pupils of the private tutors who have been chosen examiners must, we think, have a small advantage over the others, which is, however, reduced to a minimum inasmuch as the Boards of Examiners for a subject consist of four men at least. In the Queen's Colleges, Ireland, the practice is different. Here there are four colleges, which form together one University, and it is, we believe, the custom that, in conducting examinations for degrees in any college, the professors of that college should associate with themselves an outside element consisting of certain professors from the other colleges of the same University.

The practice in Scotland is somewhat similar to that in Ireland, the chief difference being that, whereas in Ireland the external element consists, we believe, of members of the teaching staff of one of the other colleges, in Scotland it consists of graduates of some one of the Scotch universities who are not engaged in university teaching in Scotland. Should the Victoria University succeed in obtaining a charter, its practice will be very similar to that in Scotland, and it must, we think, be owned that one advantage of this system is that by it all candidates are placed upon precisely the same footing.

All this, however, might be freely allowed by those who advocate an entire separation between teachers and examiners. They might reply that any such advantage is more than overborne by the manifest tendency to lower the standard of efficiency when the teacher is permitted to take any part in the examination of his pupils.

This subject has been very fully discussed in a recent report of the Royal Commissioners appointed to inquire into the universities of Scotland, one of whom was the well-known author of the "herring-brand" comparison. The following is a quotation from this report (page 49).

"The examination of the students of a university for their degrees by the Professors who have taught them, is sometimes spoken of as an obvious mistake, if not abuse: but those who are practically acquainted with university work will probably agree with us that the converse proposition is nearer the truth. In fact, it is hard to conceive that an examination in any of the higher and more extensive departments of literature or science can be conducted with fairness to the student, unless the examiners are guided by that intimate acquaintance with the extent and the method of the teaching to which the learner has had access, which is possessed only by the

teachers themselves. . . . The admirable influence which the Scottish universities have hitherto exerted upon the people of the country has been due not only to the prolonged and systematic course of mental discipline to which their students have been subjected, but to the stimulus and encouragement given to inquiring minds by distinguished men who have made the professorial chairs centres of intellectual life; and we cannot think it desirable that any such changes should be made as would tend to lower the universities into mere preparatory schools for some central examining board."

We are gratified to think that the sentiments which we expressed in these columns nearly three years ago should have received the sanction of such high authorities. As the subject is one of great importance, our readers will perhaps allow us to repeat the objections we then raised to the establishment of a Central Examining Board (see NATURE, vol. xiv. p. 255):—

"The Calendar of the Central Board must inevitably embody only the best-known and most widely-diffused results of knowledge—not that which is growing and plastic, but that which has already grown and hardened into shape—the knowledge, in fact, of a past generation which has become sufficiently well established to be worthy of this species of canonisation. A very powerful inducement is thus offered to the professors of the various colleges to teach their pupils according to this syllabus, and a very powerful discouragement to attempt to alter it. They may be men of great originality and well qualified to extend and amend their respective spheres of knowledge, but they have no inducement to do so. . . . . It is the old and time-honoured custom of killing off the righteous man of the present age in order the more effectually to garnish the sepulchres of his predecessors. Our readers are well aware that the natural philosophy course has changed its character very greatly of late years, and that for this we are much indebted to Professors Sir W. Thomson and P. Guthrie Tait. But could these men have done this under the system of a Central Board? If they had succeeded it must have been, as Galileo succeeded, against the attempt made by the ruling authorities of his day to stop his voice and strangle his originality."

It has always been a source of infinite amazement to us that a single man of eminence should come forward to advocate the gigantic apparatus for cram implied in a Central Examining Board.

May the day be far distant when the rising generation shall all be required to feed upon such rations! One is tempted to think that the advocate of this system must surely have suffered a transmutation similar to that which overtook Bottom, who, in consequence, entertained quite original notions on the subject of food. "I could munch," said that worthy, "your good dry oats. Methinks I have a great desire to a bottle of hay; good hay, sweet hay, hath no fellow."

ORGANISMS IN THE BLOOD, AND THE GERM THEORY

The Microscopic Organisms found in the Blood of Man and Animals, and their Relations to Disease. By Timothy Richards Lewis, M.B., Army Medical Department, Special Assistant to the Sanitary Commissioner with the Government of India. (Calcutta, 1879.)

WE have here in a small illustrated work an able critical *résumé* of some of the most important facts previously known on the subject together with others not hitherto published, tending not only to increase our knowledge, but also to throw light upon the general question of the relations of the microscopic organisms found in the blood to disease.

Nearly two-thirds of the work refers to the existence in the blood of vegetal organisms of the type of Bacteria, Bacillus, and their allies, while the remaining third relates to the existence in this situation of animal organisms. We have in this latter part a brief but interesting history of what is known concerning the existence of Nematoid hematozoa in the lower animals, and also of what has been learned concerning the embryos of the *Filaria sanguinis-hominis*, first discovered by the author in 1872, in the blood of persons suffering from Chyluria.

It seems evident from the account here given that we have still almost everything to learn as to the source and parental forms of these embryo Nematoids found in the blood of man. The hypothesis of Manson concerning the part played by mosquitos as intermediate hosts (within which some of the embryos swallowed may undergo development, and from the bodies of which parent-forms, capable of infecting man, may find their way into drinking water) seems, from the careful observations made by Lewis, to be rendered more than doubtful. The relations of these organisms to the morbid conditions with which they are associated are, indeed, full of the most puzzling difficulties. It is somewhat doubtful whether the mature form of this helminth has yet been discovered, notwithstanding the observations of Dr. Bancroft in Australia, and of Dr. Lewis himself (as referred to on pp. 85–89). The fact of the persistence of the envelope of the ovum as a diaphanous sheath, surrounding each of the young embryos found in the blood of man, would seem to the writer strongly to suggest the probability that the embryos in question have been liberated at once into some portion of the vascular system, rather than that they have entered it from without by penetrating its walls. If such a process of struggling through tissues were to take place, their thin diaphanous envelopes would stand a good chance of being torn and left behind.

Nematoid helminths have long been known to occur in the blood of many birds, and Dr. Lewis says: "I have examined a considerable number of the ordinary Indian crow (*Corvus splendens*), and have found that the blood of nearly half of those which have come under my notice have contained embryo hæmatozoa of this character. Sometimes they are in such numbers as to make it a matter of surprise how it is possible that any animal can survive with so many thousands of such active organisms distributed throughout every tissue of its body. The birds did not appear to be affected in the slightest degree by their presence. In their movements they are very similar to the nematoid embryos found in man; they are, however, considerably smaller, and manifest no trace of an enveloping sheath."

Again, observations made many years ago by MM. Gruby and Delafond went to show that 4 to 5 per cent. of the dogs in France harboured microscopic nematodes in their blood; Lewis ascertained in 1874 that more than a third of the pariah dogs of India are similarly affected, whilst Dr. P. Manson has shown that this kind of parasitism affects at least an equal proportion of dogs in China. The embryo nematodes belonging to dogs of these

different countries seem to agree with one another in all their characters. It is important to note that their presence is not associated with the existence of any definite disease. The dogs harbouring such parasites are outwardly indistinguishable from others which have them not. Strange as this may seem, it is also strange that the mode in which the embryo organisms gain access to the blood is still involved in great obscurity. It is true that, by several observers at different times, thread-like mature nematodes (*Filaria immitis*) have been found in more or less abundance in the right chambers of the heart of the dog. These have been found to be extremely common by Dr. Manson in China, and might therefore naturally enough be considered as the source of the multitudes of embryo nematodes found in the blood of these animals. But if true for China, it ought also to hold good for India; yet Dr. Lewis says:—"It seems somewhat strange that, notwithstanding the marked prevalence of embryo hæmatozoa, the *Filaria immitis* has not, so far as I can learn, been recognised in India. I have often searched specially for it but in vain. The only mature parasite which appears to affect the circulatory system of dogs in this country is the *Filaria sanguinolenta*, a description of which, together with an account of the pathological changes which are caused by it during its development in the walls of the aorta and adjacent tissues, was published by me in 1874."[1] But then, the same writer adds:—"Notwithstanding the circumstance that this is the only mature helminth which I have found associated with the embryo hæmatozoa of India, I cannot believe that there is a genetic connection between them, for it frequently happens that the mature worm may be present in abundance unassociated with blood embryos of any kind, and sometimes it is found that the latter exist without any trace of the former."

What has been said above suffices to show the very considerable gaps in our knowledge concerning the life-history of the Nematoid hæmatozoa of man and animals, and also the tendency so frequently met with among some observers to bridge these gaps by unsatisfactory explanations deduced from a too-narrow survey of the facts—a perennial source of error peculiarly common in regard to this class of questions.

Of the protozoa referred to as being found in the blood of the lower animals the newest and perhaps the most interesting are those now first described by the author as existing in that of Rats. Being directed by the Indian Government to make observations on the spirillum occurring in the blood of patients suffering from the Bombay fever, the author says: "Whilst doing this I had occasion to examine the blood of a considerable number of animals, and eventually (July, 1877) detected organisms in the blood of a rat which, at first sight, I took to be of the nature of vibrions or spirilla." The organisms, of which figures and photographs are given, are each of them provided with a long and very distinct flagellum, though otherwise they are not very different in appearance from some bacilli. Subsequent observations showed Dr. Lewis that whilst such organisms do not seem to exist in the blood of mice they are to be found in two species of rats, viz., *Mus decumanus* and *Mus rufescens*. Concerning their prevalence and pathological significance in these animals, he says:—"I have examined the blood of a great number of rats for the purpose of ascertaining what proportion of them contains these organisms in their blood, and find that of those specially examined for this purpose, their existence was demonstrated in 29 per cent. Sometimes, however, the numbers detected were very few, not more than one or two in a slide, but in the greater number of cases they were very numerous, every slide containing several hundreds. . . . . With regard to the health of the rats in which these flagellated organisms were detected, there was nothing to suggest in any way that they were less healthy than others not so affected, and I have repeatedly kept rats for a considerable time for the purpose of observing whether any special symptoms would be manifested. . . . . When it is considered that thousands of active beings of this character can exist in the blood without in any appreciable manner affecting the health of their host; and when it is further considered that these organisms must consume at least as much, if not far more, oxygen than bacteria, bacilli, and spirilla, it becomes difficult to understand how it comes about that, to a like action on the part of the latter is ascribed the asphyxia and the other morbid conditions which characterise death from splenic disease and allied affections." Such a view has been put forward by MM. Pasteur and Joubert, though it is well known, and has been pointed out by Virchow amongst others, that the proportion of bacilli in the blood at autopsies, bears no sort of relation to the severity of the disease previously existing in the persons under examination.

But it is in regard to these vegetal organisms existing in the blood of man and some animals that the larger part of Dr. Lewis's memoir refers. He evidently entertains a clear view of the principal phenomena to be considered in reference to this part of the subject, and exhibits a rare absence of a tendency, which is unfortunately but too common, to slur over fundamental difficulties standing in the way of the acceptance of the "Germ Theory of Disease"—or the "Doctrine of Contagium Vivum" as it is sometimes termed. In addition to acute criticism Dr. Lewis has made known some very significant and important new facts.

After referring to the generally received view that organisms of the bacterium or bacillus type do not exist to any recognisable extent in the blood of healthy animals, and to the experiments made some years ago by Dr. Douglas Cunningham and himself, which showed how quickly, after such organisms had been purposely introduced into the blood of healthy animals, they disappeared therefrom, he says:—"It may be safely affirmed that their presence in appreciable numbers is, judging from experience, incompatible with a state of perfect health." The case in regard to these microphytes is, therefore, different from what has been stated to obtain with the animal organisms before mentioned, which may swarm in the blood of creatures who are in other respects quite healthy.

One or other of such microphytes has been found to be generally present in *charbon* or *splenic fever*, and in *recurrent fever*. M. Pasteur has of late maintained that *septicæmia* is also characterised by the existence of such organisms in the blood during life; and to this list Dr. Klein adds the so-called *typhoid fever* of the pig.

[1] "The Pathological Significance of Nematode Hæmatozoa."

It is impossible to follow the author through his discussion (pp. 11-34) of the leading facts regarding the connection of microphytes with the diseases above mentioned, but we may briefly consider the question of their causal relation to the morbid conditions with which they are severally associated.

If the organisms of this type commonly met with outside the organism are not specifically injurious when introduced into the bodies of higher animals (and this has been abundantly proved and is commonly admitted), then, the notion that those met with in certain diseases are causes thereof, must necessarily be associated with the belief that they are organisms in some way distinct from the common forms. And this is generally the case; as Dr. Lewis says:—"All the advocates of the germ theory, with very few exceptions, maintaining that the particular organism, in the particular disease in which they are specially interested is wholly distinct from all others."

This is a position which is far from having been proved, however, and is by itself an extremely questionable doctrine. There are no real morphological characters separating the bacillus of splenic fever or of "pig typhoid" from the bacillus of hay, of urine, and of multitudes of other organic mixtures. So far as morphological characters are concerned, this is practically admitted; but then it is contended by Cohn and others that difference in "physiological property" may afford sufficient ground for the establishment of specific distinctions, even in the face of morphological similarity. This is a rather hazardous doctrine, and requires to be advanced with the greatest caution. To what extent in the vegetal and in the animal scale is it to hold good; or is it to be a distinctive character confined to the most protean and highly modifiable of all organisms? On the one hand we find such an authority as Prof. Cohn of Breslau supporting the notion; on the other a scarcely less weighty authority, Prof. Nägeli of Munich, declaring that he is unacquainted with any facts really supporting such a view. He says: "I have during the last ten years examined some thousands of different forms of fission-yeast cells,[1] but (excluding *Sarcinæ*) I could not assert that there was any necessity to separate them into even two specific kinds."

Bacilli, born and bred in the midst of the blood and tissues of a diseased animal, might have certain slight molecular differences impressed upon them, by reason of which they may tend during their nutritive life-processes to secrete a poisonous chemical principle—just as the common putrefactive bacteria are known to do—and it may thus happen that the progeny of such organic units born in morbid fluids or tissues, are capable of setting up morbid processes in the animal economy such as do not follow from the addition to it of bacilli nurtured in a bland hay infusion. This is a mere surmise, thrown out as a view which may be found by some to be easier of acceptance provisionally than the notion that, among the most variable of organisms, from a morphological point of view, several "species" present themselves under precisely the same form, and that identity or difference of "species" is to be judged by the mere effects produced by their invisible molecular activities.

Further, it should be borne in mind that the association between the organisms and the diseases in question is not absolutely constant, nor is the severity of the disease in the least proportionate to the abundance of the organisms found in the animals affected. Speaking of recurrent fever Dr. Lewis says:—"Whereas spirilla could generally be detected in cases of fever of this kind, nevertheless cases every now and then occurred in which perfectly competent observers failed to detect them in the blood from first to last, and this too in cases not a whit less severe than those in which the organisms abounded and which were under the care of the same observers during the same period." This was the experience of Dr. Lewis himself.

Again, in regard to the same disease, the assumed cause will not operate when it is placed under the most favourable conditions—conditions in which it is scarcely conceivable that the organisms should fail to operate were they the veritable causes of the disease. Alluding to well-known experiments made by Obermier, the discoverer of the spirilla of recurrent fever, our author says:—"The inoculative experiments which he undertook, consisting of the injection of spirillum-blood of fever patients into the veins of dogs, rabbits, and guinea-pigs proved abortive, nor was there any effect produced by the injection by means of a subcutaneous syringe of small quantities of such blood into the bodies of healthy persons." Others likewise failed to reproduce the disease by similar means, though one observer states that he had been more successful in thus setting up the disease—irrespective, however, as he says, of the presence of spirilla in the blood with which inoculation was made.[1]

What manner of cause then is this, whose effects take place in its absence, in no corresponding ratio when present, or whose presence is followed by no effect at all? One of a strange order, truly!

But now we come to a great difficulty, an all-important matter, which in its turn has to be explained by those who cannot accept the notion that the microphytes to which we have been referring are causes of the diseases in question. Those who hold the opposite notion will naturally say to the opponents of the germ theory—But, if these organisms are not to be regarded as causes of the disease how do you account for their very frequent presence in association therewith?

Communicable or contagious diseases constitute a large class, and those in association with which microphytes have been found form only a small minority. Seeing the multitudes of observers who have been searching for them for years past in the blood of persons suffering from such affections as scarlet fever, small-pox, measles, and others, the chances that any such organisms will be found in association with these diseases may be said to be diminished to a minimum. Therefore, in so far as concerns the very frequent occurrence of organisms in the blood of persons suffering from recurrent fever, splenic fever, and some other maladies, it would be perfectly consistent (if conformable with other evidence) to regard such organisms as quasi-accidental products or epi-phenomena of the diseases in question.

If we accept the doctrine of Pasteur, Lister, and others to the effect that the blood of all healthy animals is invariably free from such microphytes, the appearance of

[1] That is, the *Schizomycetes*, in contradistinction to the true yeast-cells.

[1] The relations of this spirillum to other known spirilla is discussed at p. 46-48.

organisms in the blood as epi-phenomena in the course of certain diseases can scarcely be explained except by the supposition that archebiosis or heterogenesis (one or both) have taken place in their altered blood, or in blood and tissues simultaneously.

This the present writer long ago pointed out, and he strongly insisted upon it in a paper published about eighteen months ago,[1] but which does not seem to have reached Dr. Lewis before the printing of his present work. Attention was there specially called to the fact that organisms speedily appeared in the blood of previously healthy animals or of human beings suddenly killed, in such situations and under such conditions as to make it almost impossible to account for their presence except by the occurrence of one or other of the processes above mentioned, giving rise *in situ* to a new birth of such microphytes. Organisms can, in fact, be made to appear at will (as Lewis and Cunningham, as well as Sanderson, had shown) in localised parts of previously healthy organisms by lowering the nutrition in certain ways of such parts of the body, *i.e.*, by either tying the artery supplying the part with nutrient fluid, or by subjecting the part to the influence of some germless chemical irritant. On the other hand, when the nutrient processes throughout the body are checked by the death of the animal, the production of microphytes, which was before local, now, as the writer has several times pointed out, becomes general.

Let the germ-theorists look to these facts and give us a better explanation if they can; because in the cases above referred to, organisms appear in tissues which they themselve have proclaimed to be germless, and in blood which they have declared to be free from all antecedent signs of microphytes.

The facts of the latter order have been distinctly confirmed by Dr. Lewis. He says: "Rats were obtained, killed by means of chloroform, and set aside from three to twenty-four hours or longer, according as the temperature of the atmosphere was high or low. The result proved that almost invariably bacilli were to be found in the blood, in the spleen, and in other organs."

It appears, however, and the fact is one of considerable significance, that when death takes place in certain modes (as by poisoning with carbonic acid or carbonic oxide), organisms have a still greater tendency to appear in the blood and that they manifest themselves with surprising rapidity.

A man who was sent to seek for rats, having found, "That he could procure more than could be accommodated in the cage which he had brought with him, he obtained a large earthen vessel, transferred twenty-seven rats into it, and tied a piece of cloth over the mouth of the vessel. As may be supposed, the rats had perished before he got home—all except one. . . . I examined the blood and the spleen of twenty of these rats within about six to eight hours of their having been caught, and found in each case that there were innumerable bacilli present, in every way morphologically identical with *Bacillus anthracis*.[2] In some of the cases the number was astonishing. They were present chiefly in the form of rods, but here and there some were seen to have grown to such a length as to cover two fields of the microscope. . . . This experience tends to give support to the statement made by M. Signol before the French Academy, to the effect that motionless bacilli identical with those found in charbon, will be found in sixteen hours, or less, after death, in the blood of animals which have been asphyxiated by means of a charcoal fire."

Dr. Lewis shows that these organisms which make their appearance within the bodies of animals so soon after death are not only morphologically indistinguishable from *Bacillus anthracis*, but that they go on, under suitable conditions, to the so-called "spore" formation in precisely the same manner. The characters of these organisms under different conditions are well shown in Pl. 1.

But if mere modes of dying influence the quickness with which such organisms appear in the body after death, it is not inconsistent to suppose that they may in certain cases—that is, in association with certain morbid processes—be much more prone than in others to show themselves as epi-phenomena. And this seems to correspond with what actually occurs; in many contagious diseases, as above stated, such organisms seem to be absent, in a few they show themselves, and that by far the most frequently in cases where death is already pretty closely at hand.

Referring to the bacilli met with in malignant pustule (charbon), septicæmia, and the so-called "typhoid fever," in the pig, horse, and other animals, Dr. Lewis says: "It may be confidently stated that they are never to be detected in the earlier stages of the disease, but only at a brief period before and after a fatal termination. To my knowledge they have never been found in the blood of animals which have subsequently recovered; they have always been recognised only as one of the concomitants of impending dissolution. This is undoubtedly the case so far as the two diseases first cited are concerned."

Those who are the warmest advocates of the germ-theory of disease—a doctrine resting on sufficiently unstable foundations—are not always cautious or discreet in the way they speak of others who lean to a belief that the organisms met with in association with disease are mere epi-phenomena, often produced within the body by a process of heterogenesis. Yet the latter interpretation, so far as present knowledge goes, seems to the writer essential for the explanation of our power to determine, at will, the presence of microphytes in the germless tissues or germless blood of previously healthy animals.

H. CHARLTON BASTIAN

[1] "On the Conditions Favouring Fermentation, &c.," *Journal* of Linnean Soc. (Zool.), vol. xiv. pp. 89–93.

[2] That is, the bacillus met with in association with charbon or splenic fever.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Antiquity of Orchids

I HAVE been struck by a most cogent remark of Mr. Wallace's in his review of Mr. Allen's "The Colour Sense" (NATURE, vol. xix. p. 501), viz., "But surely in orchids the perianth is

more highly specialised than in any existing flowers whatever; and if we take into account the world-wide distribution of these plants, their intense richness in genera and species, and their wonderful complexity of structure, we must consider them as among the most ancient instead of the most recent of flowers."

Without venturing any opinion as to the geological age to which the development of this wonderful order of plants must be traced back, it seems to me that there are some classes of facts concerning our native European species which support the conclusion that their existence in their present specific characters must date from a very remote time.

1. It is an important fact that out of fifty species of orchids enumerated in Garcke's "Flora des deutschen Reiches" (exclusive of the Bavarian Alps, which possess two or three more species), not less than forty-one occur in the British Isles (besides *Neottinea intacta* and *Spiranthes romanzoviana*, not found in Germany), a proportion considerably exceeding that of phanerogams generally. Now, as it seems scarcely credible that orchids should possess means of transportation across the sea in preference to other plants, we must conclude that they inhabited the British Isles before their separation from the Continent, which involves that they occupied stations near the present coasts of Germany or France previous to a great deal of plants that reached these coasts only subsequently to the formation of the Channel. These conclusions are rather strengthened by the fact that several orchids are by no means frequent in Germany, and very rare and local in Britain, which proves that their occurrence is not to be accounted for by favourable present conditions, and even renders it probable enough that some of the species found in Germany, but not in Britain, may in the latter country have become extinct in times not very long ago.

2. Notwithstanding the light so plentifully thrown on the significance of the floral peculiarities of our orchids by Mr. Darwin's admirable investigations, there remain some species whose relations to insects, although evidently of a most specialised nature, are yet very little understood. Such seems to be the case with Himantoglossum and with Ophrys. It is therefore to be suspected that the adaptations of these species may point to insects no longer existing in our countries. However, I should not insist on this point were it not somewhat connected with the following:—

3. It has been observed by Mr. Darwin that "the frequency with which throughout the world members of various orchideaceous tribes fail to have their flowers fertilised, though they are excellently constructed for cross-fertilisation, is a remarkable fact." And further on Mr. Darwin alludes to the unknown causes which lead to the destruction of seeds or seedlings, forming a check to the multiplication of orchids. Indeed, with many of our native species, though abundantly fertilised, multiplication by seeds is evidently but a rare exception to the general rule of propagation by side-bulbs, *i.e.*, mere individual persistence. Thus the wonderful contrivances for cross-fertilisation point back to different conditions of life in the past, under which their function must have been much more active and important than it is now.

There may, I think, be found analogous cases in very different quarters of the vegetable kingdom; for instance, the frequent reduction of the peristome of mosses to mere rudiments is probably connected with actual preponderance of vegetative propagation over propagation by spores. In the orchids, too, there are already perceptible some traces of a regressive change of the apparatus for cross-fertilisation (for instance, in *Ophrys apifera*), as will be inevitable in the course of ages, whenever specialised structures are no longer sustained by active function, leading to their reproduction under the agency of natural selection. Perhaps such regressive change goes on more slowly in cases of merely vegetative propagation.

Finally, I may allude to the fact of our native orchids belonging to very different groups of the order, and this enhances the argument for antiquity, based on their geographical distribution.

D. WETTERHAN

Freiburg im Breisgau, May 10

Barometric Pressure and Temperature in India

IN order to satisfy myself as to whether some of Mr. Broun's conclusions (NATURE, vol. xix. p. 6) held good when inland stations were included in the comparison, I recently examined in detail the pressure and temperature oscillations at fifty-one stations in the Indian peninsula, computed from the means given in Mr. Blanford's "Indian Meteorologist's *Vade Mecum*." As these stations represent every part of the country, the results afford a basis for deduction of sufficient extent to be reliable.

An inspection of these shows (1) that the range of pressure-oscillation corresponding to 1° F. *varies* very much at different places, its extreme limits being 0·002 in. at Leh, and 0·032 at Vizagapatam, and its mean value for all the stations 0·017 in.

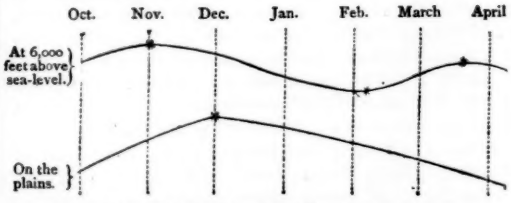
2. That on arranging the stations in order of elevation, it is plain that this variation is partly related to the height above sea-level, being least at Leh (11·538 feet), the most elevated station, and increasing from thence downwards at the mean rate of about 0·002 in. for every thousand feet of descent. The numerous deviations from this rule, however, especially at the lower elevations, make it evident that other factors operate besides height, such as distance from the coast and latitude. Though no rigorous comparison with these has as yet been made, a mere inspection of the results is enough to show that proximity to the sea, and, therefore, *ceteris paribus*, greater humidity is associated with a greater barometric oscillation corresponding to 1° F.[1]

3. That when the element of horizontal space alone is considered, the pressure oscillation increases with the temperature oscillation, but not very regularly, and that while this relation holds pretty generally in the plains, it disappears altogether at the more elevated stations, or, when the element of vertical space is introduced.

Now while the pressure ranges generally decrease pretty regularly as we ascend, the temperature-range remains about the same at different heights. The decrease, therefore, in the pressure-oscillation for 1° F., noticed in the case of elevated stations, must plainly be solely due to the contraction which takes place in the pressure-range.

The diminished mass of atmosphere above the more lofty stations, doubtless in a great measure accounts for this diminished amplitude of the oscillation. Another important factor, however, in this result, must not be overlooked, viz., the *double* annual oscillation of monthly mean pressure which takes place at stations of 6,000 feet and upwards in height, apparently throughout India, the effect of which is sensibly to diminish the absolute annual range of pressure-oscillation at these heights.

In fact, the curves representing the mean monthly barometric pressure in the winter at the hills, and on the plains respectively, may be taken to approximate more or less in character to those in the adjoining figure.



Pressure Curve (the critical points are marked with asterisks).

Now as the pressure on the plains is made up of the pressure at a height of 6,000 feet + the weight of the stratum of air between, it is evident that the latter must reach its maximum somewhat later than December. Moreover, as the winter depression at the highest stations is considered to be caused by the inrush at their level of the saturated anti-monsoon at this season,[2] the direct effect of the cold of this season in increasing the density, and hence the pressure of the atmosphere, will only be felt in the stratum of air between them and the plains. It is im-

[1] This relation appears to be independent of that due to elevation, with which it might be thought identical, owing to the general decrease in the heights as we travel seawards. The following stations which have nearly the same elevation, but are at widely different distances from the sea, will show this very clearly:—

	Height above sea in feet.	Bar oscillation for 1° F.
Lucknow	369	0·017
Sibsagar	332	0·028
Difference ...	37	0·011

Now if the approximate rule for difference of elevation already mentioned, viz., a decrease of 0·002 inch in the bar-oscillation for 1° F. for every 1,000 feet of ascent be applied in this case, the decrease at Lucknow should evidently be inappreciable. As it is, however, it is of very considerable magnitude.

[2] *Vide* "Indian Meteorologist's *Vade Mecum*," by H. F. Blanford, p. 75.

portant, therefore, to find out when the maximum average density, or what is practically the same thing, the maximum barometric weight of this stratum, occurs, and more especially to see whether it coincides with the epoch of minimum temperature, which, as a rule, occurs in January throughout India.

The following table, in which I have calculated the mean monthly barometric weight of such a stratum in different part of the country, will show that the maximum invariably occurs in January, that is to say, it *coincides* with the epoch of minimum temperature. Two bars placed underneath a figure indicate the maximum pressure or weight of the year; one bar, the secondary maximum at the hill-stations in the spring.[1]

Stations.	Elevation above sea-level in feet.	Mean monthly barometric pressure in inches.						
		October.	November.	December.	January.	February.	March.	April.
Leh	11,538	19·714	·707 *	·728	·553	·571	·656	·630
Lahore	732	29·144	·262	·332	·243	·237	·107	28·962
Stratum between—thickness	10,806 weight	9·430	·555	·604	·690	·666	·451	·332
Chakrata	7,052	23·332	·356	·352	·304	·313	·325	·309
Roorkee	887	28·965	29·102	·150	·108	·050	28·965	·853
Stratum between—thickness	6,165 weight	5·633	·746	·798	·804	·737	·640	·544
Darjeeling	6,912	23·436	·472	·449	·382	·368	·364	·363
Goalpara	386	29·461	·593	·641	·610	·544	·459	·383
Stratum between—thickness	6,526 weight	6·025	·121	·192	·228	·176	·095	·020
Ranikhet	6,069	24·108	·180	·158	·079	·070	·055	·070
Lucknow	369	29·503	·651	·696	·641	·596	·481	·348
Stratum between—thickness	5,700 weight	5·395	·471	·538	·562	·526	·426	·278
Wellington	6,200	24·217	·245	·256	·208	·226	·246	·247
Madras	22	29·847	·922	·965	·944	·921	·895	·843
Stratum between—thickness	6,178 weight	5·630	·677	·709	·736	·695	·649	·596

* To avoid repetition, I have merely given the decimals after the first column. In every instance of omission the last prefixed integer is to be supplied.

Without going any deeper into the matter, it must, I think, be generally admitted that the preceding facts not only dispose of Mr. Broun's objection to the idea that pressure and temperature are related, because the epoch of maximum atmospheric pressure on the plains of India generally *precedes* that of minimum temperature, but also show how abortive any attempt to base inductions regarding a secular variation in solar heat, upon the results of comparing the annual range of monthly mean pressure, or even the mean annual pressure, for a number of years in succession in different parts of India, must necessarily prove, unless they be duly taken into consideration.

With reference to Mr. Broun's conclusions alone, the following modifications should be attached, according to the results of my investigation.

1. The annual oscillations of monthly mean pressure and monthly mean temperature bear an exceedingly *variable* ratio to one another in India, such variation being a function partly of the altitude, and partly of the distance from the coast.

2. Non-coincidence of the critical epochs of monthly mean pressure and temperature, cannot be rigorously employed as an argument against the hypothesis, hitherto generally accepted, of a causal connection between them.

E. DOUGLAS ARCHIBALD

Insect Galls Buds

INSECT galls are held to be "excrescences"; a "diseased condition of vegetable tissue"; and they are supposed to result from the "injection of a fluid," or from some "secretion." The student may most easily begin an investigation of galls with the dissection of those produced by the turnip weevil (*Curculio pleurostigma*) on the bulb of the Swede. The roots of Swedish turnips are frequently covered with hundreds of irregular spherical warts, from ·03 to ·75 of an inch in diameter, growing either singly or crowded together in clusters. These warts are regarded by M. Woronin (*Plasmodiophora brassicæ*, Pringsheim's *Jahrb.* xi. B. p. 548) as resulting from the fungus which he has discovered to be the cause of club-rooting in cruciferous plants. I believe that on this point M. Woronin has been misled. The true clubs produced by his fungus are entirely distinct from these root-nodes. Under favourable conditions the root-nodes have been found to give rise to tufts of leaves; a fact which I can confirm by many examples presently growing in my possession. Dissection of these nodes, on Swedes, shows that they contain none of the plasma and spores which constitute the bulk of the true clubs. They are, in fact, tuberculated buds arising directly from medullary rays in the root to which they are attached. These can be traced through the enveloping parenchyma into the nodes, where they are seen to give rise to masses of contorted and branching leaves. The nodules within the bark of the beech, hazel, and other trees, are of the same character as those on the turnip. The medullary nexus of these nodules sometimes comes straight from the centre of the tree into the node, and sometimes runs along like a cord under the outer layers of the bark, entering the node by the end.

Let a dissection now be made of one of the weevil galls on the bulb of the turnip. The second or third slice will show the outer foliations, exactly similar to those of the root buds. When the centre has been reached, where the maggot will be found, there will also be found a vascular pencil running up from a medullary ray in the bulb, and bearing on its top a bud of the same description as that produced by a ray running out from a root. The insertion of the ovipositor brings a medullary ray into action, producing a tuberculated bud, and it is only the bud which the larva feeds upon. The growth of a bud is an intelligible cause of the growth of a gall, but we can infer nothing from the injection of a fluid.

All insect galls are in reality leaf-buds, or fruit-buds. They are not mere amorphous excrescences. The vascular lines which would form leaves can easily be followed up the structure of the oak-leaf galls. And in cases where the egg has been deposited in the tissue of a young branch the cap of the gall is sometimes surmounted by a leaf two or three inches long. But in the large blue Turkish galls many lacunæ occur where the fleshified leaves have not filled up the spaces between them. The morphology of the hollow woody shell, and its inclosures of starch, &c., found in the interior of these galls I hope to work out by and by. It is a curious fact that various microscopic fungi are matured in the interior of imperforate galls.

A. STEPHEN WILSON

North Kinmundy, Aberdeen

[1] In selecting the particular station on the plains to be used in each case, I have endeavoured as far as possible to fulfil two requisites: (1) proximity to the hill-station, (2) low elevation above sea-level.

Cyclones

MR. BARHAM, in NATURE (vol. xviii. p. 249), concludes that "a cyclone is occasioned by the meeting and passing each other of a northerly and a southerly current, so that they pass each other on the left hand respectively." Supposing this to be true for the northern hemisphere, we must for the southern hemisphere substitute *right* hand for *left*.

There is nothing in this contrary to dynamical principles, but the facts of the geographical distribution of cyclones appear to show that the eddies or swirls in which they originate are formed, not by north and south currents *passing* each other, but by the same *meeting* each other, that is to say, in the zone where the north and south trade-winds meet, when this zone is at some distance from the equator. Cyclones are not formed on or near the equator, because there the earth has no rotation relatively to an axis drawn vertically to its surface.

Mr. Blanford has written in NATURE (vol. xviii. p. 328), showing that Mr. Barham has not accounted for the motive power of the cyclone, and explaining it by the liberation of latent heat from the condensation of vapour in an ascending current at the centre of the cyclone. This explanation was first given by Espy in his "Philosophy of Storms," and is certainly true. But the two questions are quite distinct, viz., what sets the cyclone going? and, how is it supplied with motive power?

Three conditions are needful for the formation of a cyclone—first, an eddy produced where currents of air meet; second, sufficient "steam power of the atmosphere," as Espy calls it, to produce a strong in-draft to the centre of the eddy; third, a position sufficiently far from the equator for the currents of air towards the centre to be sensibly deflected by the earth's rotation.

But how is the in-draft first set up? I reply, by the centrifugal force of the eddy causing a barometric depression at its centre, whence follow cold, the condensation of vapour, and the liberation of heat which had been latent. The liberated heat expands the air in the upper strata, thus supplying the motive power of the cyclone. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, April 20

Showers of Rain and Gusts of Wind

IT is a matter of common observation that showers of rain are usually accompanied by more or less violent gusts of wind, but as far as I know no explanation of the fact has yet been offered.

The cause I am about to suggest must be productive of some result, but whether it is sufficient to account for the whole phenomenon I cannot say without quantitative observations, though I guess it is.

It is quite certain that the actual velocity of even large drops of rain is very small compared with that which they would acquire by falling through the same height *in vacuo*, and, practically, a drop may be considered to fall with uniform velocity during the whole time of its descent.

Now, after a drop has ceased to accelerate, it leaves an amount of water in air equal to the weight of the drop and the distance through which it falls, and most of this will appear as a current of air accompanying and following the drop.

In fact, when the drops which compose a shower are falling without accelerating, the air through which the shower falls is acted on by a downward force equal to the weight of the shower, and the downward current of air thus caused must spread laterally as it approaches the ground.

Thus, if a shower were to fall on a calm day, there ought to be a wind on the ground blowing in all directions from the shower as a centre. The rough experiment of throwing a shovelful of sand into the air and watching the dust as it reaches the ground serves very well to show the kind of thing which must happen. But when there is a wind blowing at the time the shower falls, which is generally the case, another, and perhaps more potent, cause than the mere lateral spreading of the downward current comes into operation.

The wind at the surface of the ground is moving more slowly than that at a higher level, because of the retarding effect of friction, and the effect of the shower will be to import air with a high lateral velocity from the upper regions to the lower, where the velocity is small.

With regard to the magnitude of the force which the shower exerts on the air, if we take the rainfall as 2 centimetres per hour, the velocity of the falling drops as 7 metres per second, and the height of the cloud as 700 metres, not improbable numbers, for a thunder-shower, the pressure per square metre of shower is 560 grammes, but the downward velocity which this force would generate in the air would depend on the total area of the shower, and would vary from place to place in the shower itself. A. MALLOCK

May 8

Phosphorescence

THE study of phosphorescence has lately received a considerable impetus, mainly from its having been made use of in a commercial form for clock faces, door plates, &c., but as Prof. Morton lately remarked, the present producers must have discovered some method of greatly increasing the luminosity of the sulphide used. After great difficulty I succeeded in getting a small quantity from the French makers, the same that I know Mr. Crookes had in obtaining it from the same source. Its luminosity is undoubtedly infinitely superior to that of any of the old methods of production, and gives hopes that further advances may be made. My reason for troubling you with this letter is to put on record a curious fact that has come under my notice in making some experiments detailed in the *Photo News* for May 2, with a view to making luminous photographic images in various ways—that is, that not only light, but heat produces the phosphorescent light. If we take a sheet of card and dust it over with the powder, after coating it with a sticky varnish and allowing to dry, we have a surface that when exposed to daylight for a few seconds will remain luminous for a certain time afterwards. If we place a transparent positive in front we have an evanescent photographic image presented to us on removing to a dark room, but if after simply exposing the sheet to daylight we place the tips of the fingers against the back of the card, spots of two or three times the luminosity will appear at these places showing that the heat from the hand has a great increasing action. The same occurs if the paper has not been exposed to light, the mere warmth of the hand being sufficient to render the sulphide luminous. Here we have light produced by warmth on a small scale. That phosphorescence is yet in its infancy I am convinced, and also that it will yet have a greatly extended future. WALTER B. WOODBURY

Manor House, South Norwood, S.E.

A Large Egg

ONE of my Houdan fowls has laid an egg weighing 7 oz.; her ordinary eggs weigh 2½ oz. I ordered my man to blow the egg in order to preserve the shell, when I was surprised to find that, besides a small yolk and much white of egg, it also contained a *perfect ordinary-sized egg*. This is now lying loose within the large shell, which latter measures 8¼ inches and 9¼ inches in its two principal circumferences. E. L.

Barham, Ipswich, May 6

THE IRON AND STEEL INSTITUTE

THE annual spring muster of this young and vigorous society, now in the tenth year of its age, and numbering close upon a thousand members, was held, according to custom, in the house of the Institution of Civil Engineers in Great George Street, last week. This gathering has been awaited with considerable interest for some time past, as communications of more than usual importance were expected upon the problem of dephosphorising ordinary brands of cast iron, such as are smelted from the stratified ores of Cleveland, Lincolnshire, and Northamptonshire, sufficiently to be able to produce from them steel of fair merchantable quality; and the attendance fully justified the expectations, the large meeting room being, as a rule, filled to overflowing each day within a very few minutes after the opening of the proceedings. With the exception of a morning devoted to complimentary and formal business, including the address of the new president, Mr. Edward Williams, who succeeds Dr. Siemens, and, in a few pages, presented a bold and rapid sketch of the progress of the malleable iron and steel industries since 1855, the year of Bessemer's great invention, and the presentation of the medal to Mr. Peter

Cooper, of New York, the father of the American iron trade, and the founder of the Cooper Institute, probably the largest free technical school in the world, the three days of the meeting were given up to the reading and discussion of papers in the thorough and workmanlike manner that has distinguished the Institute from its earliest meeting to the present time. Of prominent interest among these communications was undoubtedly that by Messrs. Thomas and Gilchrist on the Elimination of Phosphorus in the Bessemer converter, describing a series of experiments in continuation of others previously brought before the Institute, made at Blaenavon and Dowlais in South Wales and at Messrs. Bolckow and Vaughan's steel-works in Cleveland. The essential novelty in these experiments is the use of lime and oxide of iron as a flux in the Bessemer converter, lime being also used as a refracting lining in place of the ordinary siliceous sand or ganister. By this comparatively simple change it is found that the highly phosphuretted iron of Cleveland, containing 1 per cent. and upwards of phosphorus, may be so completely purged from that objectionable metalloid as to yield a steel, or rather, to use the proposed international nomenclature, an "ingot metal," which in this particular compares favourably with that blown from hematite pig-iron, the amount of phosphorus ranging from ·03 to 0·15 per cent. in various samples.

The presence of a large excess of earthy base, *i.e.*, lime, in the slags, appears to be the essential condition of success, and the formation of such a fluid basic slag at an early stage of the operation is of equal importance, as it enables the oxidation of both carbon and phosphorus to go on simultaneously. The composition of these slags is utterly unlike those obtained in the Bessemer process, as ordinarily worked, which are essentially similar to manganese augite; while those of the new process contain from 33 to 37 per cent. of lime, and about as much silica; though not exactly representing any natural mineral, are nearer in constitution to the olivine group of silicates. That the phosphorus is removed as phosphate of calcium, probably diffused through a mass of smolten silicates of calcium iron and manganese, there can be but little doubt, but the point, apart from its practical bearing, is of considerable scientific interest, and it seems not unlikely that microscopic investigation might throw some light upon it, unless, indeed, the slags should prove so opaque as to resist this particular method of inquiry. At any rate, one cannot but be struck with the analogous occurrence of apatite in basalts and other igneous rocks containing a low proportion of silica.

As regards the practical value of the process it would be premature to speak; many of the points raised in the discussion by way of objection, such as the increased volume of slag produced, a serious nuisance in the comparatively confined space of a Bessemer casting pit, the possibly small duration of the converter linings, &c., being obviously only matters of detail. That a very considerable success has been achieved in these experiments there can be no doubt, and that the iron smelters of Cleveland as well as those of Luxemburg and Lorraine will be fully alive to the advantages which the new process promises them is equally certain. At the same time the hematite iron trade, though not so completely master of the field as formerly, will no doubt be fully able to hold its own, and there will probably be found to be ample room for both east and west coast as steel producers. Some among us may hope as a consequence to hear less of the so-called phosphorus steels produced by dosing phosphorised iron with manganese, now that the more rational method of taking the phosphorus out of the iron may be used, in preference to disguising it.

The paper by Mr. Snelus covers nearly the same ground as that of Messrs. Thomas and Gilchrist, as it describes a number of experiments made in Bessemer converters with a lime lining first at Dowlais and subsequently Workington in Cumberland some years since with substantially the same results. That these experiments were not further carried out is sufficiently explained by the fact of the author being at the head of an establishment producing one of the purest qualities of cast-iron in the country, and therefore his interests were not in the direction of making lower class metal available; and any one who knows how the West Cumberland Works have progressed under Mr. Snelus' management will find sufficient excuse for his name not being more prominently identified with the new process. The fact of a West Coast man having been the first to demonstrate the feasibility of steel-making from Cleveland iron is a source of gratification to the local papers, and to those who have neither Cumberland nor Cleveland proclivities, it will be gratifying to know that two of the three authors of the paper in question, namely, Messrs. Gilchrist and Snelus, are graduates of the Royal School of Mines. As a contribution to the working out of the practical details of the process, Mr. Riley's paper deserves notice, although no very considerable principle is involved. The use of lime as a lining for Bessemer and other steel-melting furnaces is attended with some difficulty, as the consolidation of dry quicklime by ramming and subsequent heating is in many ways an unsatisfactory method, and its conversion to a plastic mass by means of water is not possible, owing to the chemical changes set up by hydration. These inconveniences Mr. Riley proposes to remedy by making the lime plastic with petroleum or other hydrocarbon oils, giving a mass which can be moulded by pressure and consolidated by burning in the same way as ordinary fire-bricks, the small quantity of oil being driven off at the temperature of firing. The material used is the magnesium limestone of Yorkshire, which gives bricks sufficiently hard to resist carriage and a certain amount of hard usage. Of the other papers read, that by Mr. Pattinson, of Newcastle-on-Tyne, describing a new method of determining manganese in iron and iron ores, is of considerable value as giving an exact method of indirect analysis which can be carried out in a short time as an alternative to the rather tedious direct methods of determination at present in use.

The remaining communications, more particularly those on the various uses of steel, as for example, in ship building by Mr. Barnaby, in bridge building by Mr. Maynard, and in general engineering work by Mr. Adamson, though of interest, are more so from the discussions produced than from any positive information contained. The close of the meeting was marked by the announcement of Dr. Siemens' munificent offer of 10,000*l.* towards the building fund of a new house for the Institute and the other societies representing applied science, to be erected in Westminster, a project which has been spoken of for some time, but which will no doubt with such a favourable beginning soon become a reality. It is to be hoped that in erecting a new scientific palace, whether on the Thames Embankment or elsewhere, the example of Burlington House will not be followed, where a large and costly pile of buildings has been erected without a single good-sized meeting-room in any one of the houses.

THE METEOROLOGICAL CONGRESS AT ROME

THE second International Congress of Meteorologists has just been held at Rome, on the invitation of the Italian Government. At the time of the first Congress at Vienna in 1873, it had been wished that a second should take place in three years' time, but for various reasons the meeting was postponed until Easter, 1879. Delegates were present from all the countries of Europe except Turkey, and Gen. Myer of the United States crossed the Atlantic, but, unfortunately, to arrive too late. The actual foreign delegates present were:—(Aus-

tria) Dr. Hann, Dr. Lorenz, Dr. Paugger, Dr. Müller, and Lieut. Weyprecht; (Hungary) Dr. Schenzl; (Bavaria) Dr. v. Bezold; (Belgium) Prof. Houzeau; (Denmark) Capt. Hoffmeyer; (England) Prof. Smith and Mr. Scott; (France) M. Hervé Mangon, Prof. Mascart, Lieut. Brault; (Germany) Dr. Neumayer, Dr. Bruhns, Dr. Auwers; (Greece) Prof. Kokides; (Holland) Dr. Snellen; (Norway) Prof. Mohn; (Portugal) Capt. de Brito Capello; (Russia) Prof. Wild; (Spain) M. Aguilar, Capt. Pujazon; (Sweden) Prof. Rubenson; (Switzerland) Prof. Plantamour; Italy sent Prof. Blaserna, Prof. Palmieri, Padre Denza, Prof. Tacchini, M. Salvatori, Prof. Pittei, and Prof. Cantoni. Of foreign guests there were present Dr. Hellmann, Prof. Mendeleef, Prof. Weihrauch, and Prof. Zenger.

Prof. Buys Ballot, the president of the Committee which had made the preparations for the Congress, was unavoidably absent, owing to domestic affliction, and his place was taken by Prof. Cantoni, who was elected president of the Congress. MM. Plantamour[1] and Wild were elected vice-presidents, with Capt. Hoffmeyer and Mr. Scott as secretaries.

The proceedings were opened on April 14 by M. Depretis, the Premier, in the absence of the Minister of Agriculture and Commerce, M. Majorana Calatabiano. A reply to his speech had been prepared by Prof. Buys Ballot, and was read by M. Mascart. Mr. Scott then read the Report of the Permanent Committee of the Vienna Congress, containing a list of the special treatises prepared for submission to the Congress at Rome. The existence of these treatises, several of which are of considerable value, forms the most important feature of the proceedings of the meeting of 1879.

For the consideration of the several questions of the programme, five committees were appointed: 1. Organisation; 2. Publications; 3. Instruments and Observations; 4. Telegraphy, Maritime Meteorology and Agricultural Meteorology; 5. Distant Stations and Mountain Observations. The Committees met frequently, and the Congress held five general meetings, concluding its business in eight days of very hard work.

The following will give a general idea of the resolutions adopted:—

The idea of an international institute met with very little favour, but instead thereof, an international meteorological committee consisting of nine members was elected. This body possesses no executive powers, but is charged with the duty of endeavouring to forward the prosecution of definite inquiries into various meteorological problems by friendly co-operation between the several institutes and individuals who may be disposed to undertake such inquiries, as, *e.g.*, the construction of isobaric charts for the globe. The committee has also to see to the carrying out of the resolutions of the Congress, and to report on the degree to which those of the Vienna congress have been carried out. The members of the committee are chosen from different countries, and their names are as follows:—

Buys-Ballot (Holland), Cantoni (Italy), Capello (Portugal), Hann (Austria), Mascart (France), Mohn (Norway), Neumayer (Germany), Scott (England), Secretary, Wild (Russia), President. All communications are to be addressed to Mr. Scott. As regards the form of publications, the schedules proposed in 1874 by the permanent committee of the Vienna congress were adopted, and, in fact, are already very generally in use. The Congress took no measures to enforce uniformity of hours of observation, the problem presenting too many difficulties. Each country was invited to prepare for its own principal stations corrections for diurnal range for the more important elements. The preparation of a catalogue of existing meteorological literature, including papers in periodicals, was recommended, such catalogues having already appeared at Brussels and in London (for the library of the Meteorological Society).

With reference to the subjects embraced under "instruments and observations," the most important resolutions were the following:—

The different institutes were recommended to effect a comparison of their respective standard instruments; the method of determining the fixed points of thermometers proposed by M. Pernet in his report on the subject was provisionally approved; the Congress did not venture to prescribe a single mode of exposure for thermometers suitable to all climates; the subject of earth-temperature was strongly recommended for study. The Congress received a communication from a M. de Rossi, on what he calls "endogenous meteorology," *i.e.*, the influence of atmospherical changes on earthquakes, and recommended him to prosecute his studies further.

The regulation of the Vienna congress in favour of very large rain gauges was rescinded, as well as that prescribing a height of 4½ feet above the ground for the instrument.

The international telegraphic code proposed in 1874 was recommended for general adoption. It was not found practicable to introduce into it a notice of "cirrus" cloud observations, but this latter subject was strongly recommended for study.

The subject of ocean meteorology was left to the special offices which are occupied therewith. With reference to the simultaneous observations made for the U.S. Signal Office, the Congress hoped they will be continued. As to the construction of daily synoptic weather charts for the Atlantic and Europe, a joint proposal by Dr. Neumayer and Capt. Hoffmeyer to continue and enlarge the scope of the charts published by the latter gentleman was approved. In regard of agricultural meteorology, it was decided to recommend that a private conference of persons interested in and possessing special knowledge of the subject should be held in the course of the next twelve months.

With reference to the establishment of stations in distant islands, as, *e.g.*, in the Pacific Ocean, it was decided that none such could be organised by international co-operation, but that individual governments should be requested to found stations in such localities, and that all maritime nations should be requested to instruct the officers of any exploring expeditions they may respectively send out to visit any such outlying stations as occasion may offer.

As regards Continental stations in low latitudes, the Congress resolved to request the Brazilian Government to establish meteorological stations, and to request the Royal Society of London to endeavour to secure the continuation of the publication of Mr. J. Allan Broun's work at Trevandrum. Several resolutions were passed relating to the importance of observations taken in balloons and on mountain tops. The subject of the changes in the size of glaciers, as indicating changes of climate, was recommended to the notice of the Alpine Clubs.

The final resolution of the Congress had reference to the proposal of Count Wilczek and Lieut. Weyprecht to maintain for a year a series of observing stations round the North Pole. It was resolved that, if possible, an official conference of representatives from governments disposed to co-operate in the undertaking should be held at Hamburg in October next; M. Weyprecht explaining that he could not accept a later date for the conference, as his own departure for Nova Zembla, his chosen post, would take place before next spring, and as the funds for his expedition were already contributed. The meetings terminated on April 22.

The Congress was entertained with the most splendid hospitality. His Majesty the King received the delegates at a banquet on April 21, on which occasion they were

[1] M. Plantamour's name was inadvertently omitted from our note of NATURE, vol. xix. p. 590.

personally presented to the King and Queen, who conversed most graciously with each of them. On the 22nd the Minister of Agriculture entertained the Congress at a State dinner. On the 20th the Syndic of Rome had given a reception in the Capitoline Museum, which was illuminated for the occasion. For their own part the foreign delegates invited their Italian hosts to a dinner at the Hotel de Russie on the 19th.

The proceedings were closed by a very graceful and munificent act of hospitality. The entire Congress, with the ladies who had accompanied some of the members, received free tickets for Naples and became the guests of the Italian Government for two days and a half. An expedition to Vesuvius, which was arranged for them, proved a complete success. The courtesy and forethought of the Italian officials extended to every detail which could contribute to the comfort of their visitors. The day was one of unclouded enjoyment; the weather was a perfect specimen of an Italian spring, and Vesuvius was tranquil enough to allow the more adventurous members of the party to explore every part of the crater, only deigning to eject a few stones as Parthian arrows at the descending meteorologists.

The Congress at Rome will remain in the memory of all who took part in it as one of the pleasantest and most successful opportunities of international scientific intercourse which has ever been organised.

OUR ASTRONOMICAL COLUMN

TEMPEL'S COMET (1867 II).—The following ephemeris of this comet is deduced from M. Gautier's elements, but with the perihelion passage corrected to May 6·9537 G.M.T. to accord with the approximate position observed by Dr. Tempel on April 24:—

At Greenwich Midnight

1879.	Right Ascension.	Declination.	Log. distance from Earth.	Log. distance from Sun.
	h. m. s.	° ′		
May 15 ...	16 50 3 ...	−16 17·6 ...	9·8959 ...	0·2487
17 ...	— 49 15 ...	16 36·6		
19 ...	— 48 20 ...	16 55·9 ...	9·8911 ...	0·2492
21 ...	— 47 20 ...	17 15·6		
23 ...	— 46 16 ...	17 35·8 ...	9·8880 ...	0·2498
25 ...	— 45 8 ...	17 56·3		
27 ...	— 43 58 ...	18 17·1 ...	9·8866 ...	0·2506
29 ...	— 42 45 ...	18 38·1		
31 ...	— 41 31 ...	18 59·3 ...	9·8871 ...	0·2515
June 2 ...	— 40 16 ...	19 20·6		
4 ...	— 39 2 ...	19 42·0 ...	9·8895 ...	0·2527
6 ...	— 37 49 ...	20 3·4		
8 ...	— 36 38 ...	20 24·8 ...	9·8937 ...	0·2539
10 ...	— 35 29 ...	20 46·1		
12 ...	16 34 23 ...	−21 7·2 ...	9·8996 ...	0·2554

The intensity of light is at a maximum about May 26, but is not then very materially greater than on April 24, when the comet was described by Dr. Tempel as a faint object. In 1867 it was observed at Athens until the theoretical intensity of light had diminished to 0·21, so that with the larger telescopes in the southern hemisphere observations may be possible in August. The position for August 13·5 is in R.A. 16h. 58·8m., Decl. − 29° 11′. When brightest in 1867, the nucleus was star-like and of 9·7 m., the value of I. at the time being 1·23.

During the ensuing revolution considerable perturbation may again result from the action of the planet Jupiter, though not to so great an extent as in the revolution 1867-73. Using the above time for perihelion passage in the present year and taking the mean daily motion, 593″·184, it appears that the least distance of the comet from the planet will be about 0·58 of the earth's mean distance from the sun, in the middle of October 1881, and that from the beginning of July, 1881, to the middle of January, 1882, the comet will always be within 0·65; this will again necessitate a rigorous calculation of the perturbations to insure a near prediction of the comet's track in the heavens in 1885.

It was at one time suggested that the object detected by M. Goldschmidt on May 16, 1855, while searching for De Vico's comet of short period, might have been the comet of which we are writing; but the late Dr. von Asten undertook the calculation of the perturbations backward for two revolutions from 1867, and found that the comet being in perihelion on February 1, 1856, with elements not very different from those of 1867, could not have been identical with Goldschmidt's nebulosity. So far, therefore, as is known at present, there is no recorded observation of Tempel's comet previous to April 3, 1867, notwithstanding it may have performed many earlier revolutions in the restricted orbit it now describes; but the case is similar with other comets of short period.

BRORSEN'S COMET.—Dr. Krueger has kindly sent us two meridian observations, made at Helsingfors, of the star over which Major Tupman witnessed a nearly central transit of this comet on May 3 (NATURE, vol. xx. p. 27). The star was rated 8·7 mag, and its mean position for 1875·0 was R.A. 6h. 9m. 14·84s., Decl. + 61° 28′ 8″·5. Whence the apparent position of the comet by Major Tupman's observation was on May 3, at 10h. 11m. 14s. G.M.T. in R.A., 6h. 9m. 39·15s., Decl. + 61° 28′ 30″·9, showing corrections to the ephemeris, published in this column, of + 13s. in R.A., and + 2′ in declination.

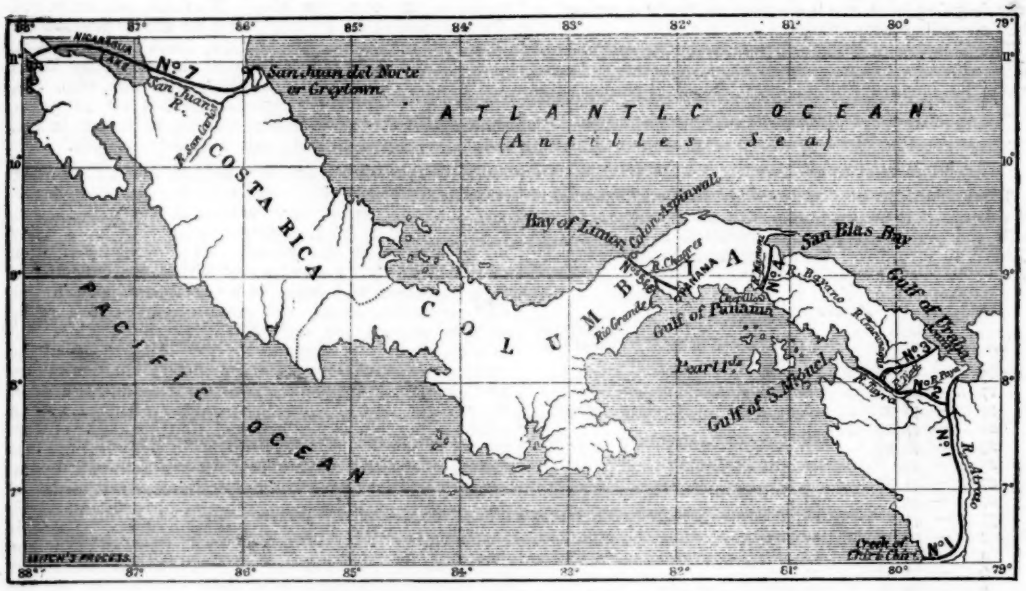
ANNUAIRE POUR L'AN 1879, PUBLIÉ PAR LE BUREAU DES LONGITUDES.—It has not been from want of appreciation of the astronomical contents of this small volume, so ably edited by M. Lœwy, that earlier allusion to it has not been found in this column. It provides information of a kind which is not to be met with in so collective a form elsewhere, and must be a valuable adjunct to the astronomical amateur, who needs reference to a really reliable authority on such details as the maxima and minima of variable stars and the general elements of the solar system, including periodical comets. M. Lœwy presents in one list the positions and limiting magnitudes of the variable stars of which the periods are known, and in a second list similar particulars of a large number of stars known to be variable, but of which the periods have not yet been determined; these lists are followed by an ephemeris of maxima and minima, arranged in order of date, with the minima of the more rapid variables, Algol, λ Tauri, S Cancri, δ Libræ, and U Coronæ. There is also a carefully-prepared list of the elements of the minor planets to No. 191 inclusive, such a catalogue, in fact, as has often been inquired for by those who do not see the *Berliner Astronomisches Jahrbuch*. The general contents of the *Annuaire* are as full and varied as usual, but for the reasons named it has now an especial value for amateurs of astronomy, and its almost nominal price places it within reach of all. M. Janssen makes an important addition in his "Notice sur les Progrès récent de la Physique solaire," which is accompanied by a photograph of a portion of the sun's disc, taken at the observatory at Meudon, June 1, 1878, illustrating the rapid transformations occurring in the photospheric network and granulations within less than an hour.

AN INTER-OCEANIC CANAL

TO-DAY the long-talked-of International Congress on the subject of a canal across the Central American Isthmus meets in Paris under the presidency of M. De Lesseps. This question is a very old one, but the movement which has led up to the present Congress commenced only in 1875, at the instigation of Lieut. Lucien N. B. Wyse, of the French Navy. At the International Congress of Geography of that year the subject of the

piercing of the American isthmus was seriously discussed. Under the presidency of M. De Lesseps an international jury was appointed to decide upon the best track and to give its opinion on the financial and economical possibility of the execution of the scheme. It was resolved to postpone the meeting of the grand jury until after the exploration of the Paya-Caquirri line. In less than a year a society of exploration was constituted, the capital subscribed, the concession of a canal obtained from the Government of Columbia, and towards the end of 1876 an expedition set out from France for the Isthmus of Darien under the command of Lieut. Wyse. From that time till a few months ago, Lieut. Wyse, with the aid of Lieut. Reclus, M. Sosa, and a staff of engineers, surveyors, &c., has been carrying on his explorations in various parts of the isthmus, so that now a vast quantity of data has been collected, and will be brought before the Congress which meets to-day. Whatever decision the Congress may come to on the immediate subject under discussion, the value of these, as well as previous explorations in connection with an inter-oceanic canal, are very great so far as our knowledge of Central America is concerned. They have added much to the scanty information we had on the physical geography, hydrography, fauna and flora of the region explored.

Not to go farther back, the first serious work of the isthmus in recent years, with a view to the construction of a canal, seems to have been undertaken by the French engineer, Napoleon Garella, who in 1843 explored the isthmus of Panama, and proposed a canal with locks and a tunnel from Simon Bay, in the Atlantic, to the Bay of Vaca de Monte, in the Pacific. But it has been the United States which, until the French Expedition, has been most earnest in the task of endeavouring to find a practicable route for such a canal, as, on the face of it, to them, in spite of their trans-continental railway, it would be of immense commercial advantage. It would reduce by more than half the sailing distance between their east and west coasts. Therefore since 1850 numerous expeditions have been sent out by the U.S. Government to



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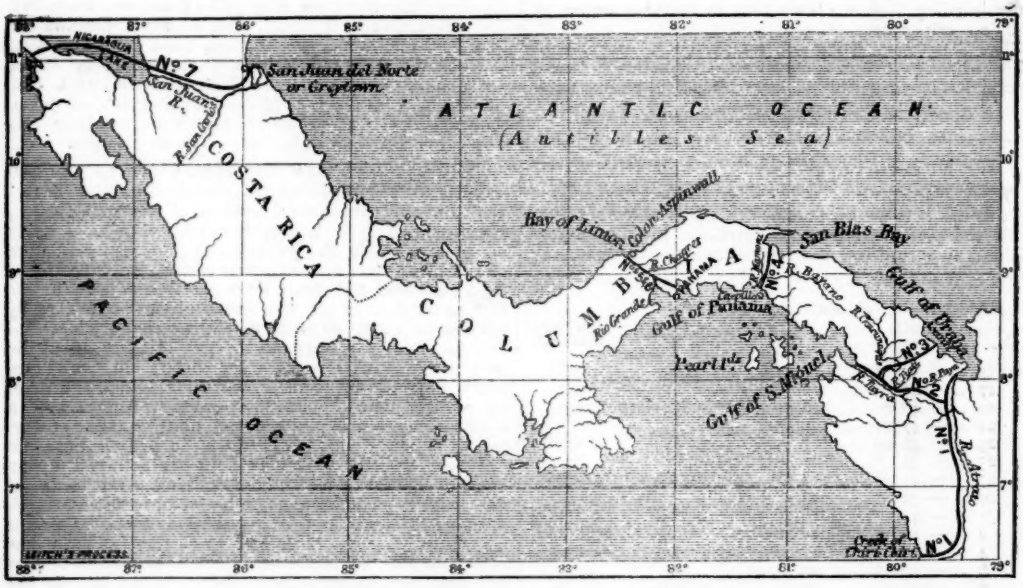

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palatine and pterygoid cartilages appear, and it then subdivides, the pterygoid getting the larger half but no teeth, and the ethmo-palatine the lesser half and all the teeth. The form of these parts varies much in the different genera.

The apparent uniformity of the Batrachia, as to the skull especially, is quite belied by what is found on dissection. The disposition of parts in the skull varies greatly.

A careful study of the morphology of the Batrachia suggests many things as to their genetic origin, and accords very accurately with the known facts of their geographical distribution. On the whole the types are more generalised in the west than in the east, and much more so in the south than in the north.

There is nothing in which the frogs and toads differ more from the salamanders than the extraordinary development of the middle ear; the latter always modify a part of the capsule so as to produce a fenestra ovalis and stapes: but in the former, as a rule, the upper element of the hyoid arch is modified into the chain of the middle ear, the spiracular cartilage into the ring of the ear-parchment, and the skin covering the first cleft into the parchment of the ear drum. In certain kinds of frogs and toads these parts are as much arrested as in the salamanders and newts; in all of them that part of

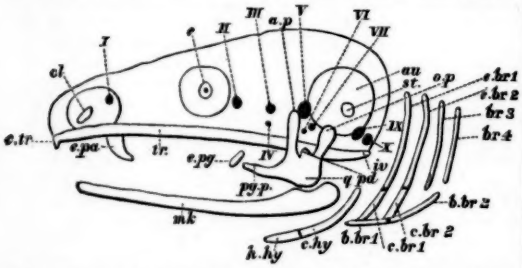

FIG. 2.—Diagram of chondrocranium of young Axolotl. The Roman figures indicate the nerve foramina. *a.p*, ascending process of suspensorium; *au*, auditory capsule; *b.br*, basi-branchial; *br*, branchial arch; *c.br*, cerato-branchial; *c.hy*, cerato-hyal; *c.tr*, coruna trabeculæ; *e*, eye; *e.br*, epi-branchial; *e.hy*, epi-hyal; *e.pa*, ethmo-palatine; *e.pg*, epi-pterygoid; *iv*, investing mass; *mk*, Meckel's cartilage; *ol*, olfactory capsule; *o.p*, orbital process; *pd*, pedicle; *q*, quadrate; *st*, stapes; *tr*, trabeculæ.

the hyoid arch which is developed into the middle ear-chain is later in its appearance than that which carries the tongue.

It is evident that the great polymorphism of these types is due to the influence of their surroundings upon them.

The larger kinds are a long while undergoing metamorphosis, and in their adult condition they possess many bones which can only be found again in the long-extinct Amphibians of the Coal Measures. With regard to small and arrested kinds, which, as a rule, belong to the Notogœa, their arrest in metamorphosis can be paralleled with various stages of development in higher kinds. For example, in *Pseudophryne bibronii*, a small Australian bombinator toad, the auditory apparatus is arrested at the same stage in which we find it in our native kind up to midsummer, that is to say, there is no columella; in *Rhinoderma darwinii*, a South American form, the columella is a thick short wedge of cartilage terminating externally in a fibrous thread, precisely like the rudiment we find in our own native kinds in the beginning of July; and in a small African species of frog, *Gomphobutes*, the columella is developed to the condition of that of our native kinds a month or two later, and it is not ossified.

The relative size of the perfect larva to the adult is extremely variable in the Batrachia. In *Bufo chilensis* the recently metamorphosed young is no larger than a common house-fly, the tadpole being about twice the size, and in *Pseudis paradoxa*, a South American form, which is scarcely larger than our native frog, the tadpole attains the size of a herring or a red mullet. In the case of *Pipa monstrosa* from Surinam, the young when ready to leave the dorsal pouches of the mother are scarcely as large as a honey-bee, but as perfect in their metamorphosis as the young of our native frog and toad at the end of a year; the mother toad is twice as large as a large female native toad.

It is evident that those forms in which the tadpole is of such a large size, have a tendency to remain in the larval condition, and are thus a little in advance of the axolotl, most of the individuals of which are arrested as permanent larvæ, a few only undergoing transformation into true gill-less salamanders (*Amblystoma*).

The manner in which the different kinds of Batrachia are modified, both as to their outward form and skeleton, each one to suit its own particular kind of life, is very interesting and instructive. The little tree-frogs have in their skull a large membranous fontanelle, covered merely with skin, as in young infants; their toes are flattened, and thus they are able to climb with ease and safety amongst the foliage, the colours of which they imitate. Other forms, such as *Pelobates fuscus*, living on the ground, have their small brain encased in dense and almost enamelled armour, and besides this protection, the above-mentioned *Pelobates*, or garlic toad, has the power of giving forth an offensive odour from the skin. This last kind is almost devoid of a middle ear, and the columella is extremely small; the little tree-frogs, on the contrary, have very perfect ears. Thus in *Pelobates* we have a skull approaching that of the Labyrinthodonts, while in the tree-frogs the skull resembles very much that of a shark or skate.

Some large kinds, such as *Ceratophrys dorsata*, have, besides the dense bony plates covering the head, similar large scutes over their shoulders.

The frogs and toads that possess a tongue have their eustachian passages wide apart, as in Mammals, but in the tongueless forms, *Pipa* and *Dactylethra*, the two tubes meet at the mid line, as in birds. They have all two separate occipital condyles, as in Mammals.

Taking the Batrachia through and through, they form a wonderfully perfect chain of types; they do not, however, lead us directly to any existing groups of high Vertebrates, but rather look towards Mammalia than in the direction of reptiles and birds.[1]

REPTILES

Snakes.—The snakes have probably arisen from ancestors which possessed limbs, which, however, have become inconvenient to their descendants, and have therefore been supressed. The boas and pythons, as well as the *Typhlopidæ* and *Tortrices*, have, however, rudiments of posterior extremities.

There is a certain embryonic simplicity in the internal skull, but the outer skull is very perfect and marvellously specialised, as is also the spine. There are no exoskeletal elements whatever behind the head, but in the head there are some small cartilages besides the investing bones, which latter form three-fourths of the skull.

The bones of the skull are the most adamantine to be found anywhere in the vertebrate kingdom, while the cartilage, where it survives (as in the *trabeculæ*), is perfectly elastic, and untouched by the ossifying process. Where sutures persist they are perfectly distinct to old age; when ankylosis takes place along any particular line it early obliterates the least trace of the original suture.

A large part of the base of the skull is more simple and embryonic than anything to be seen in the skull of the

[1] Besides the two papers in the *Philosophical Transactions* (1871 and 1876), the lecturer is preparing a large memoir on the structure and development of the skull in a large number of larval and adult forms of Batrachia.

adult lamprey, while other parts are as much specialised as anything that can be found in the skull and face of a man. There are no *dermostoses*, and no instance is known in which a splint bone (*parostosis*) unites with any part of the ossified endocranium, except in the base of the skull, where a rostrum of membranous origin unites with the basisphenoid. The skull is largely formed of splint bones, and the inner parts of the face are also formed of membrane bones, which, however, represent cartilaginous elements in fishes. The outer parts of the face are formed of bones that have no cartilaginous representatives in the lower forms, but exist as splint bones or dermal scutes in the Ganoids, osseous fishes, and Amphibia. So that in a mere study of the development of the snake, without reference to other types, we should find no difference between the premaxillaries and the maxillaries on the one hand, and the palatines and the pterygoids on the other.

The whole apparatus of the palate and upper and lower jaws is a very loosely articulated structure, and each bone is kept as much as possible in the form of a simple bar or splint.

The hinder part of the endocranium and the auditory capsules are intensely ossified, and contrary to what is seen in any other vertebrata, the orbito- and ali-sphenoids are separately developed in the membranous walls of the skull; they are both very small, especially the former. The three bony elements of the auditory capsule remain permanently separate, but the pro-otic unites with the ali-sphenoid, the epi-otic with the supra-occipital, and the opisthotic with the ex-occipital.

The only visceral elements that are developed behind the mandible are the rod of the columella and the minute stylo-hyal which coalesces with the quadrate.

Lizards.—The lizards form a very large group of reptiles, all of which, like the snakes, have a movable pier to the lower jaw, but which have a very remarkable diversity of external and internal characters. Besides the typical lizards, this order includes the Amphisbænæ, the blind-worms, the chamæleons, and the New Zealand *Hatteria* (*Sphenodon*).

For practical zoology, all that can be seen and handled in an animal without dissection is, of course, readiest and best for classification, but to establish a sound foundation, it is necessary to go much deeper. The brain, heart, and other internal organs present very poor distinctive characters in the families under consideration when compared witn the skull, face, spine, and limbs.

In the most serpentiform of lizards there are at least limb girdles even if there are no limbs.

In several kinds, such as the Blind-worms (*Anguis fragilis*) and the Australian *Cyclodonts*, there is a dermal scute inside each horny scale. In the latter and also in the Skinks (*Mocoa*), the underlying parietals and frontals are extensively ankylosed to the overlying bony scutes. In our native sand-lizards the investing bones that lie next the skin, where there are no intervening muscular fibres, become rough and thick, like ordinary dermal scutes; the horny skin over them is thin and has no bony plates under it as in the body. In the larger number of lizards, including the blind-worms, the three normal ventral splint-bones—a pair and an odd one—are seen; in *Hatteria* these are continued along the abdomen segmentally, as in the Plesiosaurs. These bones are suppressed in the chamæleon, which deserves to represent a sub-order by itself, so little has it conformed to the normal type of the lizard.

In the chamæleon the outer bones of the head become crested, scabrous, and fretted with all sorts of markings. In such types as *Monitor*, *Stellio*, and *Iguana*, the cranial roof-bones and the bones of the face are not rough, as in the sand-lizard, nor fretted, as in the chamæleon, but smooth, as in the serpents and birds.

One of the most remarkable things in the skull of some of the types is the retention of rows of bones the counterparts of which must be sought for in the ancient Amphibia of the Coal Measures and in the still more ancient Ganoid fishes of the Old Red Sandstone. In the little nimble lizard, for example, we have two rows of such bones strengthening the eyebrows, and another row over the temporal region, besides a bone flooring the outer nostril, which belongs to the same category.

A sort of anticipation of the hinge of the bird's upper jaw is seen in the sand lizard and in the large stump-tailed lizard of Australia (*Trachydosaurus rugosus*), in which forms a fenestra appears in the orbito-nasal septum. This does not appear in the ostrich tribe, but begins in the Tinamous. Considered evolutionally, this is an exceedingly interesting and instructive fact.

The parietals, which are simply roof-bones, are propped up by a slender rod of bone, the so-called *columella* (*epipterygoid*), which must not be confounded with the bone of the same name in the middle ear. The chamæleons, however, do not possess this bone, and they are also deficient in respect of their ear, having neither the drum and its parchment nor any rudiment of a cochlea.

There is usually only one premaxillary, but in the Skinks and Cyclodonts there are two.

When the birds are spoken of as being genetically related to the lizards, it must be understood that *modern* lizards are not referred to; they are in many respects as much specialised as the birds themselves, and only form a *side branch*, and not a *leader* of the vertebrate life-tree.

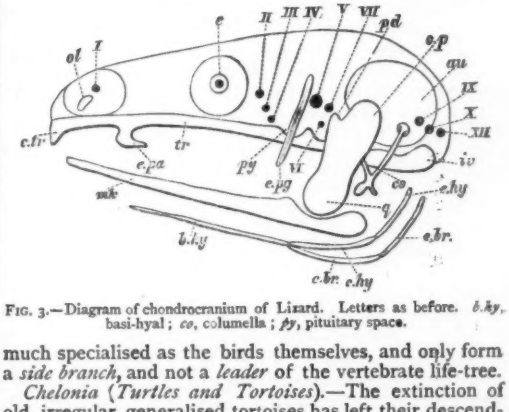

FIG. 3.—Diagram of chondrocranium of Lizard. Letters as before. *b.hy*, basi-hyal; *co*, columella; *py*, pituitary space.

Chelonia (*Turtles and Tortoises*).—The extinction of old, irregular, generalised tortoises has left their descendants in a very neat and orderly state, showing a great uniformity and distinctness from the other reptiles, in the fact that the body is inclosed in a strong bony box formed of the carapace and plastron.

This box is formed of bony plates, covered with horny scales, which, however, do not conform to them. The inner skeleton in the walls and roof of this curious building has become fused with the outer; below there is no inner skeleton, these animals having neither sternum nor sternal ribs, the plastron and the marginal plates of the carapace being formed by ossifications in the dermis. The carapace is principally formed by the bony matter from the spines of the back and of the rib-shafts spreading into the thick overlying web of fibrous tissue.

In some of the Mud Tortoises the edges of the carapace are often soft, and the plastron is very imperfect. In *Chelydra* and the *Matamata* the neck and tail are much longer than usual, and remind the observer of the Plesiosaurs.

The plastron is formed of four bones on each side, the anterior pair being separated by a single median piece, and thus only one of the median ventral bones of a Plesiosaurus or Hatteria is retained.

There are no teeth, the jaws being covered with horn, and forming an efficient shearing apparatus. The facial

bones are few and expanded; the nasals, pre-frontals, and lacrymals are represented by a single bone, and there are no superorbitals. There is no *second* temporal bone, as in lizards, but an additional cheek-bone, the *quadrato-jugal*, unites the jugal to the pier of the lower jaw, a very exceptional thing in lizards (*e.g.*, *Hatteria*.)

The large investing bones have to a great extent aborted the proper internal skull; this is especially the case between the capsules of the ears and the labyrinths of the nose.

In the logger-head and green turtles the cranial compartment has a "shed" or "lean-to" on each side, formed by the parietals, post-orbitals, and squamosals. The pterygoids form the greater part of the bony floor of the skull, between which and the descending wall there is a little bony "prop" corresponding to the *columella* (*epipterygoid*) of the lizard.

The mandible has no *splenial* element, as in bony fishes and frogs. There are two arches developed behind the mandible—the hyoid, or tongue arch, and a second, corresponding to the first gill arch in fishes and Amphibia. The pier of the arch of the lower jaw (*quadrate*) is hollowed into a drum, over which is stretched its "opercular fold," as the parchment, in which there is an annular cartilage. The pier of the tongue-arch is a long slender rod, the *columella*, the proximal part of which answers to the stapes, and the rest to the incus; it stretches between the *fenestra ovalis* and the drum membrane.

This peculiar hollowing out of the quadrate is a promise of the air-cells seen in many of the bones of birds.

The development of the embryo of the Chelonia takes place in essentially the same manner as in birds; yet, in the young of the green turtle, half an inch long, the rudiments of the carapace can be seen.

The parental form of all the modern Chelonia was probably intermediate between the extinct *Rhynchosauria* and the *Plesiosauria*, and the existence in the Cape toad (Dactylethra) of characters that correspond very closely with those of the Chelonia, suggests a relationship between certain ancient forms of the Batrachia and the generalised types from which the Chelonia have sprung.

(*To be continued.*)

GEOGRAPHICAL NOTES

IT would appear as if the War Office authorities expected the special service officers who are on the point of starting for Zululand to find opportunities for doing useful geographical work in that country, as we understand that the Intelligence Department are supplying them with the most recent edition of "Hints to Travellers," published under the authority of the Council of the Royal Geographical Society, and edited by Mr. Francis Galton, F.R.S.

THE news of the death of the Marquis Antinori, the leader of the Italian Expedition to Central Africa, is, we are glad to say, contradicted.

THE Congress of Commercial Geography, to be held at Brussels in September, will be presided over, not by M. Bamps, but by Lieut.-General Liagre, president of the Belgian Geographical Society and perpetual secretary of the Belgian Academy of Sciences. M. du Fief will act as secretary.

NEWS from Leipzig states that the president of the Meteorological Office of that city, Baron A. von Danckelmann has been invited by M. Sibiriakoff to take part in the expedition to the Siberian Arctic Sea, and that he has accepted the invitation, the necessary permission having been readily granted to him by the Saxon Government. The expedition was to sail on May 14.

Les Missions Catholiques publishes an interesting communication from Père Gourdin, a missionary in the Chinese province of Szechuen, in which he gives an account of the little-known tract of country in the south of the province, called Kienchang.

THE last report of Her Majesty's Consul at Newchwang contains much information in regard to Manchuria which is of interest from the standpoint of commercial geography. There are reasons for believing, in his opinion, that in spite of the watershed between the valleys of the Liao and the Sungari, Newchwang will successfully compete with Nicholayesk for the most valuable part of the trade with the latter valley, and those of the two great affluents of the Sungari, the Nonni and the Hurka. A great point in its favour is that the Liao River is remarkably easy of access, while the navigation of the Amur at its entrance is extremely intricate, and is closed by ice for seven months in the year. Colonisation, we are told, is proceeding in the valley of the Yalu-Kiang, the boundary between China and Corea. With regard to the production of opium in regions at a distance from Newchwang, Mr. Consul Adkins says that it is growing in most parts of the province of Fêngtien (South Manchuria), in many parts of the Kirin province, and in a daily increasing area in the southern portion of Eastern Mongolia, notably in the tract of country which lies on the right bank of the Sungari in the angle formed by the reaches of that river above and below its junction with the Nonni, east and south-east of Petuna.

A FURTHER instalment of the *Transactions* of the Asiatic Society of Japan, which has just come to hand, contains some interesting notes of a visit paid last year to the little-known island of Hachijô by Mr. F. V. Dickens and Mr. Ernest Satow, the Japanese Secretary of H.M.'s Legation at Yedo. The island in question, it may be useful to note, is erroneously called Fatsizio on our Admiralty chart; it is the last but one of the chain which extends south of the promontory of Iazu in almost a straight line.

IN a brief account of the work of the China Inland Mission in Burmah we find some notes of interest respecting a visit to the Kah-chen hills near the Chinese frontier. The village visited is situated among the mountains at an elevation of 4,000 feet above the Burmese town of Tsee-kaw. The Kah-chen houses are described as being built of bamboo, and more substantially than those of the Burmese. The roof of each is about 100 or 150 feet in length; at the entrance for some 15 feet the sides are open or merely formed of open bamboo work. The poles which support the roof of this part of the building are ornamented with the heads and horns of buffaloes sacrificed to the *nats* or spirits. On either side of a long passage are small rooms, the first of which is the guest chamber; the kitchen and general sitting-room is at the end of the passage, whence a door, always open, leads into a small raised veranda and which is entirely appropriated to the use of the *nats*, of whom the people are in great dread. The dress of the women is superior to that of their Burmese sisters, than whom they are said to be more modest. All who can afford it, wear a large silver hoop round the neck, and as many strings of red, green, blue, and white beads as they can muster. Their ear ornaments are peculiar; large flaps of ornamented cotton hang from the back of the ear, and tassels or silver tubes are passed through the lobes. All wear large coils of rattan round their bodies, and the younger ones wear bells and cowrie shells. There is, however, one objection to both men and women, viz., their great want of cleanliness.

NOTES

THE University of Edinburgh has sustained a great loss in the unexpected death of its veteran and genial professor of mathematics. Only three weeks ago, in giving the annual address at the graduation ceremonial, he in touching terms

alluded to his long length of service, and the improbability of his again addressing the collected body of graduates. The labours of the winter session had proved too much for his enfeebled health. Immediately after their close he left for the country, where he seemed at first to revive, but a cold which he caught brought on congestion of the lungs, against which he had not strength to rally. He died on the 7th inst. His eminence as a mathematician, and his excellence as a teacher, combined with his admirable personal qualities, will be long remembered by all who have known the Edinburgh University during the last forty years.

THE death is announced of Prof. Grisebach, the well-known botanist and geographer. He was born in 1814 at Hanover, and in 1841 was called as Professor of Botany to Göttingen, where he was still officiating up to his death. He contracted his illness while on a visit with his family to Italy.

M. PASTEUR is about to found, in the department of the Jura, with the support of the French Minister of Agriculture and Commerce, who has for this purpose granted a subvention of 1,000*l.*, a special laboratory for the study of all questions connected with the vine and wine. This laboratory, provided with all the means of investigation which bear on researches of this nature, will be located at Arbois, and M. Pasteur will devote six months each year to it. Important results may justly be looked for from this institution.

THE Baly Medal of the Royal College of Physicians of London has been awarded to Mr. Chas. Darwin, F.R.S.

HERR KARL BOCK, who, at the request of the late Marquis of Tweeddale, has spent eight months in exploring the highlands of Sumatra, has, the *Times* states, returned to Padang with a rich collection of natural history specimens. Among other living animals he has secured a specimen of the *Capricornis sumatrensis*, which is peculiar to the island. It is a species of mountain antelope, rarely met with, and only among the most remote and almost inaccessible peaks. Herr Bock was travelling in Lapland in the autumn of 1877, under the 71st parallel of north latitude. The autumn of 1878 was spent by him under the first parallel of south latitude.

A SERIES of "Davis" lectures upon zoological subjects will be given in the lecture-room of the Zoological Gardens, in the Regent's Park, on Thursdays at 5 P.M. The first was given last Thursday by Prof. Flower, on "Birds that do not Fly." The others are as follow:—May 15, "The Pleasures of Zoology," Prof. J. Reay Greene, M.D.; May 22, "Tails," Prof. Mivart, F.R.S.; May 29, "Parrots," P. L. Sclater, F.R.S.; June 5, "Snakes," Prof. Huxley, F.R.S.; June 12, "Nocturnal Animals," Dr. J. Murie, LL.D., F.L.S.; June 19, "Reptiles and their Distribution," P. L. Sclater, F.R.S. These lectures will be free to Fellows of the Society and their friends, and to other visitors to the Gardens.

MR. ORVILLE A. DERBY contributes to the *Rio News* some interesting information on the plague of rats in Brazil. From time to time in all parts of Brazil the plantations are subject to the depredations of armies of rats that issue from the forests and consume everything edible that comes in their way. During a recent excursion in the province of Paraná Mr. Derby found an almost universal lack of corn throughout the province, due to such invasion of rats, by which almost the entire crop of last year had been destroyed. This invasion, or plague as it is called, is said to occur at intervals of about thirty years, and to be simultaneous with the drying of the *taquara*, or bamboo, which everywhere abounds in the Brazilian forests. The popular explanation is that every cane of bamboo sprouts with a grub, the germ of a rat, within it, and that when the bamboo ripens and dies the germ becomes a fully-developed rat and comes out to prey on the plantations. An educated and observant Englishman, Mr. Herbert H. Mercer, who has resided a number of years in the province and had an opportunity of studying the phenomenon, furnished Mr. Derby the following rational and curious explanation:—The bamboo arrives at maturity, flowers and seeds at intervals of several years, which doubtless vary with the different species. The period for the species most abundant in Paraná is thirty years. The process, instead of being simultaneous, occupies about five years, a few of the canes going to seed the first year, an increased number the second, and so on progressively, till finally the remaining and larger portion of the canes seed at the same time. Each cane bears about a peck of edible seed, resembling rice, which is very fat and nourishing, and is often eaten by the Indians. The quantity produced is enormous, and large areas are often covered to a depth of five or six inches. After seeding the cane dies, breaks off at the root and falls to the ground, the process of decay being hastened by the borings of larva which live upon the bamboo and appear to be particularly abundant at seeding time. These larva have doubtless given rise to the story of the grub developing into a rat. New canes spring up from the seed, but require seven or eight years to become fit for use, and thirty to reach maturity. With this sudden and constantly increasing supply of nourishing food for a period of five years, the rats and mice, both of native and imported species, increase extraordinarily in numbers. The fecundity of these animals is well known, and the result after four or five years of an unusual and constantly increasing supply of excellent food and in the absence of enemies of equal fecundity, can readily be imagined. The last of the crop of seed being mature and fallen to the ground, the first rain causes it to decay in the space of a very few days. The rats, suddenly deprived of food, commence to migrate, invading the plantations and houses and consuming everything that does not happen to be repugnant to the not very fastidious palate of a famishing rodent. If this happens at the time of corn-planting, the seed is consumed as fast as it can be put into the ground. Mr. Mercer, who plants annually about fifty acres of corn, replanted six times last year, and finally gave up in despair. The mandioca is dug up; the rice crop, if it happens to be newly sown or in seed, is consumed, as is also everything in the houses in the way of provisions and leather, if not carefully guarded in tin trunks.

THE Congress of the Social Science Association at Manchester has been fixed to take place from October 1 to 8.

Deutsche Acclimatisation is the title of a new German journal devoted to questions connected with the acclimatisation, training, and breeding of birds. It is the organ of the German Society for the Breeding and Acclimatisation of Birds, and will appear at irregular intervals. The editor is Dr. Reichenow.

THE cryptogamous division of the herbarium of the Boston (U.S) Society of Natural History, we learn from the *American Naturalist*, has been enriched by the discovery of a valuable collection of lichens. This was formerly the lichen-herbarium of Dr. Thomas Tayler, an Irish botanist, to whom Sir W. J. and Sir Joseph Hooker gave the whole of their extensive collection of lichens, gathered during many exploring expeditions. Dr. Tayler published descriptions of these plants in the *Journal of Botany*, 1844–66, and many of the specimens are the originals of the descriptions. In 1850 Mr. John A. Lowell purchased the collection from Dr. Tayler's heirs, and it formed a part of the herbarium subsequently presented by him to the Society.

THE following (*ben trovato*, if not the other thing), seems worth reproducing from *Science News*:—It is not long ago that a young man went to one of the wise men at the Smithsonian Institution, and said: "I think I should like to be a naturalist." "Well, *be* one," replied the doctor in charge. "But I don't know how,

and wish you would get me rightly at work at the start." "Very well," said the willing master, "there is plenty to be done right here; let us begin on these fishes." Turning to a can of fishes from Arizona in spirits, he opened the cover, pulled up his sleeve, and brought forth two or three dripping examples. They were well preserved, but the smell—well, the less said about that the better; it was very "ancient" and somewhat "fish-like." "There, see what more you can get out of that can, and I'll show you what to do next." The young man paused in dismay and tugged very gently at his kid glove. Finally, in deprecating tones he asked: "Doctor, is it necessary, in order to become a naturalist, that I plunge my hands in that alcohol?" "Of course—no other way to study objects of natural history properly, except in the field." "Well," was the reply, very decided, albeit somewhat rueful, "I—I think I'll go back to Long Branch." And go back he did.

DR. HOPKINSON gave important evidence before the Electric Lighting Committee last Friday. As a result of his experiments, he found that on an average about 87 per cent. of the mechanical energy bestowed on the machine was converted into heat, but about 50 per cent. of the electricity obtained from the mechanical energy was lost in the heating of the machine and wires. The scientific considerations, he stated, had largely been touched in a satisfactory manner. Mr. Shoolbred, of the firm of Shoolbred and Co., Tottenham Court Road, gave satisfactory evidence of the working of the light in his establishment. He was burning twenty candles, which had replaced 230 gas burners. The cost to him was 37*s.* 3*d.* per night in winter, and 9*s.* 10*d.* in summer.

THE American papers state that Mr. Edison is still engaged in his experiments with reference to the electric light, and hopes yet to overcome all difficulties, and to make the light available for public use. He intends to institute a comparative trial on carbon lamps between his own machine and those of Wallace and Gramme; he does not say how many carbon lamps he can light with his machine. He is confident that he can work his system for stree and house-lighting with comparatively little loss by exhaustion of the current, by means of a cable, from a central station, the cable composed of as many strands of wire, say one-sixteenth inch diameter, as there are houses in the street to be lighted. The latest papers say that Mr. Edison has perfected his dynamo-electric machine, and with that he maintains he has solved the problem of the economical generation of electricity and the sub-division of the light. A trial of his system is stated to have worked perfectly, producing more lights and less heat with less expenditure of power than any machine hitherto constructed.

THE Meudon Aërostatic Service officers are constructing a directing balloon with screw moved by a steam-engine. They have desisted from their original scheme, which was to attach the screw to the equator of the balloon, and have acknowledged reluctantly the necessity of adopting the principles used by M. Henry Giffard, in his celebrated 1852 hippodrome experiment with a steam directing aërostat.

ACCORDING to official statistics 22,851 wild animals and 127,295 serpents were destroyed in India during 1877; while 16,777 persons died from the bites of serpents, and 2,918 were killed by tigers, leopards, wolves, and other wild animals.

Akhbar, the most influential French paper in Algeria, is devoting many interesting articles to the construction of the Trans-Saharan railway from Laghouat to Timbuktu through Touat. The preliminary surveys have been executed from the Algiers-Oran line to Laghouat.

THE last number of the Russian Physical and Chemical Society's *Journal* (vol. xi. fasc. 3) contains the annual reports of the Society, and papers on the temperatures of boiling of saturated hydrocarbons of normal structure, by M. J. Goldstein; on benzoic compounds, by M. P. Goloubeff; on aromatic compounds, by M. E. Wroblevsky; and on the transmission of a galvanic current in water when the platina electrodes are of various sizes, by M. Slouginoff.

IN a recently-published inaugural dissertation on the electromotive forces which occur in free water jets (*Ann. der Phys.*, No. 4), Herr Elster arrives at these conclusions:—1. A liquid motion *per se* produces no electromotive force. (This is against Edlund's view). 2. Capillary electric currents are simply produced by friction of the particles of the moved liquid; in the case of non-wetting liquids, by their friction on the particles of the solid wall, and in the case of wetting liquids, by friction on the particles of a layer of the liquid condensed on the surface of the solid, this layer behaving to the less dense as a heterogeneous substance. 3. The capillary electric currents discovered by Quincke are identical with the friction-currents which occur in the rubber of an electric machine, and which were first observed by Zöllner. Numerous experiments in support of these conclusions are described.

NEWS has been received from Japan that two very rich seams of coal have just been discovered in the celebrated Takashima mines. It is estimated that they will produce fully a million tons of coal. It is also reported that active measures are being taken for throwing open to foreign commerce the ports of Tsuruga and Shimonoseki.

THE first of two illustrated volumes, on the Manufacture of Sulphuric Acid and Alkalis, by Prof. Lunge, of Zurich, will be published in a few days by Mr. Van Voorst, who has also just ready for publication a supplement to C. Greville Williams's "Handbook of Chemical Manipulation."

THE fourth public annual meeting of the Sunday Society will be held in Freemasons' Tavern on Saturday, at 4 P.M. From their just published Report we see that the Society is making marked progress in the objects which they have in view.

THE supplement to the *Colonies and India* for May 10 contains a long address given to the Colonial Institute by Prof. Owen on the Extinct Animals of the Colonies of Great Britain.

WE have received a most interesting and instructive lecture on Ornithology, by Dr. H. B. Hewetson, of Leeds; its title is "Nature Cared for and Nature Uncared for, the Result upon the Hearts of Men." He tries to show how much pure pleasure can be derived from the observation of living nature, and the study not of the dead animal, but of "the life-sympathies and instincts of the object in life." The lecture deserves a wide circulation. The publishers are West, Newman, and Co., of London.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. C. A. Thomson; an Ocelot (*Felis pardalis*) from America, presented by Mr. P. Leckie; an Indian Kite (*Milvus govinda*) from East Asia, presented by Capt. Murray; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. A. Dodd; a Diana Monkey (*Cercopithecus diana*), a Subcylindrical Hornbill (*Buceros subcylindricus*) from West Africa, received in exchange; a Macaque Monkey (*Macacus cynomolgus*) from India, five Peacock Pheasants (*Polyplectron chinquis*) from Burmah, deposited; twelve Common Teal (*Querquedula crecca*), twelve Garganey Teal (*Querquedula circia*), twelve Red-headed Pochards (*Fuligula ferina*), six Tufted Ducks (*Fuligula cristata*), four Shovellers (*Spatula clypeata*), two Common Pintails (*Dafila acuta*), two Common Widgeons (*Mareca penelope*), European, purchased; an Hybrid Markhoor (*Capra megaceros*), six Seven-banded Snakes (*Tropidonotus leberis*), born in the Gardens.

RECENT CONTRIBUTIONS TO THE HISTORY OF DETONATING AGENTS[1].

III.

NOBEL has observed that if, instead of making use of the most explosive form of gun-cotton, or trinitrocellulose, a lower product of nitration of cellulose (the so-called soluble or collodion gun-cotton) is added to nitro-glycerine, the liquid exerts a peculiar solvent action upon it, the fibrous material becoming gelatinised while the nitro-glycerine becomes at the same time fixed, the two substances furnishing a product having almost the characters of a compound. By macerating only from 7 to 10 per cent. of soluble gun-cotton with 90 to 93 per cent. of nitro-glycerine, the whole becomes converted into an adhesive plastic material, more gummy than gelatinous in character, from which, if it be prepared with sufficient care, no nitro-glycerine will separate even by its exposure to heat in contact with bibulous paper, or by its prolonged immersion in water, the components being not easily susceptible of separation, even through the agency of a solvent of both. As the nitro-glycerine is only diluted with a small proportion of a solidifying agent which is itself an explosive (though a somewhat feeble one), this *blasting gelatine*, as Nobel has called it, is more powerful not only than dynamite, but also than the mixture of a smaller quantity of nitro-glycerine with the most explosive gun-cotton, as the liquid substance is decidedly the most violent explosive of the two. Moreover, as nitro-glycerine contains a small amount of oxygen in excess of that required for the *perfect* oxidation of its carbon and hydrogen constituents, while the soluble gun-cotton is deficient in the requisite oxygen for its complete transformation into thoroughly oxidised products, the result of an incoporation of the latter in small proportion with nitro-glycerine, is the production of an explosive agent which contains the proportion of oxygen requisite for the development of the maximum of chemical energy by the complete burning of the carbon and hydrogen, and hence this blasting gelatine should, theoretically, be even slightly more powerful as an explosive agent than pure nitro-glycerine.

That such is the case has been well established by numerous experiments, but although this blasting gelatine may be detonated like dynamite by means of small quantities of confined detonating composition, when it is employed in strongly-tamped blast-holes, or under conditions very favourable to the development of great initial pressure, it behaves very differently from that material, or other solid though plastic preparations of nitro-glycerine, if the attempt is made to detonate it when freely exposed to the air or only partially confined. It not only needs a much more considerable amount of strongly confined detonating composition than dynamite and similar preparations do, to bring about a detonation with it under those conditions; but when as much as fifteen or twenty grains of confined fulminate are detonated in direct contact with it, although a sharp explosion occurs, little or no destructive action results, and a considerable portion of the charge operated upon is dispersed in a finely-divided condition.

In comparing the effects of these nitro-glycerine preparations with each other and with compressed gun-cotton and preparations of it, by detonating equal quantities quite unconfined upon iron plates, the results appear to establish great superiority, in point of violence, of action, or destructive effect, of the more rigid explosive agents (the gun cotton preparations). Thus, employing iron plates 1 inch thick (supported upon an anvil with a central cavity), and 4 oz. of each material unconfined, the charges being all about the same diameter, exploded by detonators of equal strength, and simply resting upon the upper surface of the plate, compressed gun-cotton produced a considerable indentation of the upper surface of the plate, and long cracks in the lower surface; a species of nitrated gun-cotton, called tonite, produced a much shallower indentation, though still a very marked one, but did not crack the lower surface. Dynamite produced only a very slight impression upon the plate, and none could be detected by the eye on the plate upon which the blasting gelatine was exploded. The difficulties, brought out by past experience, which attend the contrivance of really comparative tests of the explosive power of such substances as those under discussion, is well exemplified by the foregoing results, which were influenced to the maximum extent by the physical characters of the several substances when thus applied, in a perfectly unconfined condition, so that the particles were free to yield to the force of the initiative detonation in proportion to their mobility. But, for this very reason, these experiments afford excellent illustration of the extent to which the development of detonation and the sharpness of its transmission through the mass is influenced not only by the inherent sensitiveness of the substance to detonation, but also by the degree of proneness of their particles to yield mechanically to the force of a blow as applied by an initiative detonation. Thus, although in comparing two substances of similar physical characters, compressed gun-cotton and compressed nitrated gun-cotton or tonite, the superiority of the pure compound over the mixture, in point of sharpness and violence of action, is well illustrated, a comparison of the result furnished by the weakest of the four explosive agents tried, viz., tonite, with that of the substance which should be superior to all the others in explosive force (*i.e.* the blasting gelatine) demonstrates the important influence which the comparatively great rigidity of the mass in the one case exerts in favouring the completeness and sharpness of its detonation in open air, and the great disadvantage under which the other explosive is applied, arising out of the plastic and therefore readily yielding nature of the material. But if, by exposure to a moderate degree of cold, this plastic nitro-glycerine preparation is made to freeze, its detonation upon an iron plate produces an indentation, as well as a destructive effect upon the lower surface of the plate, very decidedly greater than those furnished by the corresponding amount of pure compressed gun cotton. Similarly, the effect produced by the detonation of dynamite upon a plate of the kind used, is but little inferior to that of gun-cotton, and decidedly greater than that of tonite, if it is employed in the frozen condition.

A series of experiments has been made with cylinders of lead having a central perforation 1·3 inch in diameter extending to a depth of 7 inches and leaving solid metal beneath of a thickness ranging from 3·5 to 5·5 inches, according to the size of the cylinders used. These furnished results of considerable interest as illustrating the action of these several detonating agents. Charges of 1·25 oz. of each explosive substance were used throughout the experiments, and were placed at the bottoms of the holes. By the detonation of the charges the cylindrical holes in the lead were enlarged into cavities of a pear shape (and sometimes approaching the spherical form) of various diameters; in some instances the metal was besides partially torn open in a line from the bottom of the charge-hole to the circumference of the lower face of the cylinder; and in the case of some of the gun-cotton charges, the fissure in the metal in this direction was complete, the base of the block being separated from the remainder, in the form of a cone. In the first place the portions of the holes above the charges were simply left open; in the subsequent experiments they were filled up to a level with the upper surface, with dry, fine, loose sand, or with water. The dimensions of the cylinders were increased in successive experiments until, in the case of every one of the explosives used, the mass of metal was sufficiently great to resist actual fracture at the base of the cylinder. Under the condition of these experiments, more or less considerable resistance being opposed to the mechanical dispersion of the plastic explosive substances, their detonation was greatly facilitated, though even then, the holes in the lead blocks being left open to the air, some amount of the blasting gelatine evidently escaped detonation; the widening of the upper part of the charge-hole, in experiments of this nature made with the gelatine, indicated that detonation was transmitted to small portions dispersed in the first instance and in the act of escaping from the block. In all the experiments, whether the holes were left open or filled with sand or water, the effect produced upon the base of the block by the detonation of compressed gun-cotton, was considerably more violent than with the other explosive agents, indicating a sharpness of action which was only shared by the blasting gelatine when used *in a frozen state* in one of these experiments. The dimensions of the cavities produced by the gelatine were, at the largest part, considerably greater than those produced by the dynamite and nitrated gun-cotton (tonite), and slightly greater than those of the gun-cotton charges; but in the latter, the fracture of the base of the cylinder gave rise in most of the experiments to an escape of force, so that in these cases the effects of the detonation could not be well compared by measurements of the cavities. When the gelatine was converted by freezing into a rigid mass its superiority in explosive force even over compressed gun-cotton

[1] Weekly Evening Lecture at the Royal Institution, Friday, March 21, 1879. By Professor Abel, C.B., F.R.S. Revised by the Author. Continued from p. 45.

was well illustrated; the base of the lead block was all but blown out, the cavity produced was considerably the largest, and the suddenness and violence with which motion was imparted to the water tamping caused the top of the block also to be blown off in the form of a cone.

The difficulties attending the application of blasting gelatine, in some directions in which explosive agents are applied, on account of the uncertainty attending the development of its explosive force, even with the use of a comparatively powerful detonator, unless it be very strongly confined, has led to attempts to reduce its non-sensitiveness to detonation by mixing it with materials intended to operate either by virtue of their comparatively great sensitiveness or of their property as solids, of reducing the very yielding character of the substance, or in both ways.

Some of these attempts have been attended with considerable success. Thus the incorporation of about 10 per cent. of the most explosive form of gun-cotton or trinitrocellulose, in a very finely divided state, with the gelatine, renders it so much more sensitive that it can be detonated with certainty in the open air by means of the strongest detonating cap now used for exploding dynamite. This effect appears to be less due to the comparative sensitiveness of gun-cotton to detonation than to the modification effected in the consistency of the material, which, though still plastic, offers decidedly greater resistance to a blow than the original gummy substance. The particles of hollow fibre of the gun-cotton appear also to have the effect of absorbing small quantities of nitro-glycerine which are less perfectly united with the soluble gun-cotton than the remainder, and which, existing as they do in somewhat variable proportions in the gelatine, have occasionally an objectionable tendency to exudation, if the incorporation of the ingredients has been less perfect than usual. The substance, when modified as described, has no longer that great adhesiveness which is exhibited by it in the original state, and which renders it less easy to manipulate.

Lastly, its explosive force appears to be in no way diminished by this modification of its composition; on the contrary, its superiority in this respect to compressed gun-cotton becomes more manifest, as demonstrated by some of the experiments with lead blocks, while its action partakes of that sharpness peculiar to the detonation of the rigid gun-cotton, as indicated by the fissure of that part of the metal situated beneath the charge. Finely divided cotton fibre has a similar effect to trinitrocellulose in modifying the physical character and increasing the sensitiveness to detonation of the blasting gelatine, but its explosive force is, of course, proportionately reduced with its dilution with an inert substance.

Nobel has made the interesting observation that an addition to the blasting gelatine of small proportions of certain substances rich in carbon and hydrogen, which are soluble in nitro-glycerine, such as benzol and nitro-benzol, increases to a remarkable extent the non-sensitiveness to detonation of the original material; and this observation has led to experiments being conducted by engineer officers in Austria, with a view of endeavouring to convert the blasting gelatine into a material which should compete, as regards some special advantages in point of safety, with wet gun-cotton in its application to military and naval purposes, and especially as regards non-liability to detonation or explosion by the impact of rifle bullets. If boxes containing dry compressed gun-cotton are fired into from small arms even at a short range, the gun cotton is generally inflamed, but has never been known to explode. It is scarcely necessary to state that wet gun-cotton, containing even as little as 15 per cent. of water, is never inflamed under these conditions. On the other hand, dynamite is invariably detonated when struck by a bullet on passing through the side of the box, and blasting gelatine, though so much less sensitive than dynamite, behaves in the same way in its ordinary as well as in the frozen condition. The Austrian experiments indicated that the gelatine when intimately mixed with only 1 per cent. of *camphor*, generally, though not invariably, escaped explosion by the impact of a bullet, but that when the proportion of camphor amounted to 4 per cent. the material was neither exploded nor inflamed, though, in the frozen state, it was still liable to occasional explosion. These results were considered indicative of a degree of safety in regard to service exigencies, approaching that of wet compressed gun-cotton. The camphoretted gelatine still labours, however, under the disadvantage of being readily inflammable and of burning fiercely, and consequently of giving rise, like dynamite and dry gun-cotton, to violent explosion, or detonation, if burned in considerable bulk. Moreover, the camphoretted blasting gelatine is so difficult of detonation by the means ordinarily applied that a large initiative charge of a specially violent detonating mixture is prescribed by the Austrian experimenters as being indispensable to its proper detonation.

The action of camphor and of other substances rich in carbon and hydrogen in reducing greatly the sensitiveness to detonation of the preparation of soluble gun-cotton and nitro-glycerine is not to be traced to any physical modification of that material produced by the addition of such substances, and no satisfactory theory can at present be advanced to account for it on chemical grounds.

The camphoretted gelatine, like Nobel's original gelatine itself, may be kept immersed in water for a considerable time without any important change; the surface of the mass thus immersed becomes white and opaque, apparently in consequence of some small absorption of water, but no nitro-glycerine is separated, and on re-exposure to the air the material gradually assumes once more its original aspect. It has consequently been proposed to render the storage of blasting gelatine comparatively safe by keeping it immersed in water till required for use, but the test of time is still needed to establish the unalterableness of the material under this condition.

There can be little question that this interesting nitro-glycerine preparation, either in its most simple form, or modified in various ways, by the addition of other ingredients, promises, by virtue of its great peculiarities as a detonating agent, to present means for importantly extending the application of nitro-glycerine to industrial purposes; and it is not improbable that, through its agency, this most violent of all explosive agents at present producible upon a large scale may also come to acquire special value for important war-purposes.

It has been pointed out that the complete solidification, by freezing, of plastic preparations containing nitro-glycerine, such as dynamite and the blasting gelatine has the effect of facilitating the transmission of detonation throughout the mass under certain conditions of their applications, *i.e.*, when they are either freely exposed to air or not very closely or rigidly confined. But while, under circumstances favourable to the detonation of these substances, when in the frozen state, their full explosive force is thus much more readily applied than when they are in their normal (thawed) condition, the frozen substances are less sensitive to detonation by a blow or an initiative detonation. On the other hand, if subjected to the rapid application of great heat (as for example by the burning of portions of a mass of the explosive substance itself), a detonation is much more readily brought about with the frozen material than if it be in its normal condition. Thus a package containing 50 lb. of cartridges of plastic dynamite, when surrounded by fire, burned away without any indication of explosive action; on submitting 10 lb. of frozen dynamite to the same treatment, that quantity also burned without explosion, though at one time the combustion was so fierce as to indicate an approach to explosive action; but when the experiment was repeated on the same occasion with 15 lb. of frozen dynamite a very violent detonation took place after the material had been burning for a short time.

The following is offered as the most probable explanation of this result. When a mass of dynamite, as in these cartridges, is exposed to sufficient cold to cause the nitro-glycerine to freeze, it does not become uniformly hardened throughout, partly because of slight variations in the proportion of nitro-glycerine in different portions of the mixture composing the cartridge, and partly because unless the exposure to cold be very prolonged the external portions of the cartridges will be frozen harder or more thoroughly than the interior. It may thus arise that portions of only partially frozen or still unfrozen dynamite may be more or less completely inclosed in hard crusts, or strong envelopes, of perfectly frozen and comparatively very cold dynamite. On exposure of such cartridges to a fierce heat very rapidly applied, as would result from the burning of a considerable quantity of the material, some portion of one or other of the cartridges would be likely to be much more readily raised to the igniting or exploding point than the remaining more perfectly frozen part in which it is partly or completely imbedded. If the ignition of this portion be brought about (which it will be with a rapidity proportionate to the intensity of heat to which the cartridge is exposed), the envelope of hard frozen dynamite by which it is still more or less completely surrounded and strongly confined, will operate like the metal envelope of a detonator, in developing the initial pressure essential for the sudden raising of the more readily in-

flammable portion of the dynamite to the temperature necessary for the sudden transformation of the nitro-glycerine into gas, and will thus bring about the detonation of a portion of the cartridge, which will act as the initiative detonator to the remainder of the dynamite. On igniting separately, at one of their extremities, some dynamite cartridges which had been buried in snow for a considerable period, the lecturer has observed that, as the frozen material gradually burned away, very slight but sharp explosions (like the snapping of a small percussion cap on a gun nipple) occurred from time to time, portions of the frozen dynamite being scattered with some violence. It has come to his knowledge that small heaps of hard-frozen cartridges weighing altogether one pound have been detonated by igniting one cartridge which was surrounded by the remainder. These facts appear to substantiate the correctness of the foregoing explanation. They point to the danger of assuming that, because dynamite in the frozen state is less sensitive to the effects of a blow or initiative detonation, than the thawed material, it may therefore be submitted without special care to the action of heat, for the purpose of thawing it. Instances of the detonation, with disastrous results, of even single cartridges of frozen dynamite, through the incautious application of considerable heat (as for example by placing them in an oven, or close to a fire), have been, and are still, of not unfrequent occurrence, even though Mr. Nobel has insisted upon the application of heat through the agency only of warm water, as the sole reliable method of safely thawing dynamite cartridges.

While the sensitiveness to detonation of air-dry gun-cotton remains unaffected by great reduction in temperature of the mass, and while in this respect it presents advantages over nitro-glycerine preparations, wet gun-cotton becomes very decidedly more susceptible to detonation when frozen. Thus the detonation of gun-cotton containing an addition of from 10 to 12 per cent. of water is somewhat uncertain with the employment of 100 grains of strongly confined fulminate, and 200 grains are required for the detonation of the substance when containing 15 to 17 per cent. of water; but the latter in a frozen state can be detonated by means of thirty grains of fulminate, and fifteen grains are just upon the margin of the amount requisite for detonating, with certainty, frozen gun-cotton containing 10 to 12 per cent. of water.

The effects produced and products formed by the explosion of gun-cotton in perfectly closed spaces, both in the loose, and the compressed form, and by its detonation in the dry and the wet state, have been made the subject of study by Capt. Noble and Mr. Abel, the method of research pursued being the same as that followed in their published researches on fired gunpowder; results of considerable interest in regard to the heat of explosion; the pressures developed, and the products of explosion of dry and wet gun-cotton, have been obtained, which are about to be communicated to the Royal Society.

It may briefly be stated that the temperature of explosion of gun-cotton is more than double that of gunpowder (being about 4,400° C.); that the tension of the products of explosion, assuming the material to fill entirely the space in which it is fired, is considerably more than double that of the powder-products under the same conditions; that the products obtained by the explosion of dry gun-cotton are comparatively simple and very uniform under different conditions as regards pressure; that the products of *detonation* of *dry* gun-cotton do not differ materially from those of its explosion in a confined space, but that those furnished by the detonation of *wet* gun-cotton present some interesting points of difference. Messrs. Nobel and Abel are extending their investigations to the nitro-glycerine preparations.

The great advance which has been made within the last twelve years in our knowledge of the conditions which determine the character of the metamorphosis that explosive substances undergo, and which develop or control the violence of their action, finds its parallel in the progress which has been made in the production, perfection, and application of the two most prominent of modern explosive agents, nitro-glycerine and gun-cotton. Discovered at nearly the same time, less than forty years ago, the one speedily attained great prominence, on account of the apparent ease with which it could be prepared and put to practical use; a prominence short-lived, however, because the first, and somewhat rash, attempts to utilise it preceded the acquisition of sound and sufficient knowledge of its nature and properties. Even many years afterwards, when the difficulties attending its employment appeared to have been surmounted, the confidence of its most indefatigable partisans and staunchest friends received a rude shock, from which it needed the support of much faith and some fortitude to recover.

Meanwhile, the other substance, which now shares with it the honours of important victories won over gunpowder, continued to be generally regarded as a dangerous chemical curiosity, even for some time after its present position as one of the most important industrial products and useful explosive agents was being gradually but firmly secured for it, step by step, by the talent and untiring energy of a single individual.

Almost from the day of its discovery, the fortunes of gun-cotton continued to fluctuate, and much adversity marked its career, until at last its properties became well understood, and its position as a most formidable explosive agent, applicable on a large scale, with ease, great simplicity, and with a degree of safety far greater than that as yet possessed by any other substance of this class, has now become thoroughly established. Since the lecturer last discoursed on the properties of gun-cotton, seven years ago, this material has attained a firm footing as one of the most formidable agents of defence and offence. For all military engineering operations, and for employment in submarine mines and torpedoes, compressed gun-cotton, stored and used in the wet condition, has become the accepted explosive agent in Great Britain; within the last five years upwards of 550 tons have been manufactured for this purpose, and are distributed over our chief naval stations at home and abroad. Germany some years since copied our system of manufacture and use of gun-cotton; France has provided itself with a large supply for the same purposes, and Austria, where the acquisition of bitter experience of the uncertainty of gun-cotton in the earlier stages of history, naturally gave rise to a persistent scepticism regarding its present trustworthiness, appears now also about to adopt wet gun-cotton for military and naval uses.

But while the usefulness and great value of compressed gun-cotton in these important directions have been established, its technical application has made but slow progress as compared with that of the simple nitro-glycerine preparation known as dynamite, which, in point of cost of production and convenience for general blasting purposes, can claim superiority over compressed gun-cotton. Already in 1867 a number of dynamite factories, working under Nobel's supervision, existed in different countries; in that year the total quantity manufactured amounted to 11 tons; in another year the produce had risen to 78 tons; in 1872 it had attained to 1,350 tons. Two years afterwards the total production of dynamite was nearly trebled, and in 1878 it amounted to 6,140 tons.

There are as many as fifteen factories in different parts of the world (including a very extensive one in Scotland) working under the supervision of Mr. Nobel, the originator of the nitro-glycerine industry, and some six or seven other establishments exist where dynamite or preparations of very similar character are also manufactured.

How far the rate of production of dynamite will be affected by the further development of the value of Nobel's new preparation, the blasting gelatine, it is difficult to foresee, but there appears great prospect of an important future for this very peculiar and interesting detonating agent.

It is hoped that the subjects dealt with in this discourse afford interesting illustration of the intimate connection of scientific research with important practical achievements.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

DR. CARPENTER, Registrar of the University of London, announced his retirement from that office at the annual meeting of Convocation on Tuesday. A unanimous vote was passed, recognising his long and valuable services in the post which he had so long held.

THE recent retirement of Prof. Balfour from the Chair of Botany at Edinburgh has given rise to two changes in the Scottish professoriate. As his successor, our readers know, the Curators have appointed Dr. Alexander Dickson, the able Professor of Botany in the University of Glasgow. The botanical class has always been popular at Edinburgh, Dr. Balfour's students having recently numbered, we believe, upwards of 350. The class-room of the new professor, also, is so crowded that many of the auditors can hardly find standing-room, large numbers having been unable even to gain admission. Prof. Dickson is

therefore under the necessity of lecturing twice a day. His retirement from Glasgow College has opened the way for a young botanist of great promise, Dr. I. Bayley Balfour, son of the veteran professor at Edinburgh, who has been appointed by the Crown to the vacant chair. Dr. Balfour took the degree of Doctor of Science in Botany some years ago with great distinction at Edinburgh. He was selected by the Council of the Royal Society to accompany the recent Transit of Venus Expedition to Rodriguez for the purpose of making a scientific examination of that island. As the result of his researches, besides the report on the natural history, which he has sent in to the Royal Society, he has produced an excellent paper on the genus *Halophila*. Having had considerable experience in class-work under his father, as well as under Professors Huxley and Sir Wyville Thomson, he enters on his new duties with many advantages. Whether as an original investigator or as a successful teacher, he will, we doubt not, fully sustain the reputation of the Glasgow University.

We are glad to notice that the School Board for London have decided that it would be expedient to include the elements of natural science among the recognised subjects of class examination. The object of this resolution is to transfer what is called elementary science from the category of specific subjects into the category of class subjects. At present there is little inducement for pupils to take science subjects, nor will there be until it be included in the regular course of instruction in elementary schools. We hope the memorial which the Board is to prepare will be treated with the attention it deserves.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 8.—"On the Sensitive State of Electrial Discharges through Rarefied Gases." By William Spottiswoode, P.R.S., and S. Fletcher Moulton, late Fellow of Christ's College, Cambridge.

It has frequently been remarked that the luminous column produced by electric discharges in vacuum tubes sometimes displays great sensitiveness on the approach of the finger, or other conductor, to the tube. This is notably the case when with an induction coil a very rapid break is used, or when with any constant source of electricity an air-spark is interposed in the circuit leading to the tube. The striking character of the phenomena, and the opportunity which they showed for affecting the discharge from the outside during its passage, led the authors of this paper to consider that a special examination of this sensitive state would be desirable.

All the circumstances under which sensitiveness is produced appear to agree in requiring, first, that there should be a rapid intermittance in the current leading to the tube; and secondly, that the individual intermittent discharges should be small in quantity and extremely brief, if not instantaneous, in duration. Both these requirements are fulfilled by the methods used in the present investigation, viz., a Holtz machine with a suitable air-spark between the machine and the tube, and a small coil with a rapid break.

If a conductor be made to approach a tube conveying a sensitive discharge, due to an air-spark in the positive branch of the circuit, a series of effects is produced, of which the feeblest and the strongest are the most pronounced. The transition from one to the other is so rapid that the intermediate phases may be easily overlooked. In the first case, the luminous column is repelled by the conductor; in the second it is broken into two parts which stretch out in two tongues towards the point on the tube (P) nearest the conductor, while a negative halo appears between them.

That these effects are due to the inductive action of the conductor, or more particularly to re-distributions of electricity in it, co-periodic with the air-spark, and not to any permanent charge, is shown by the following experiments. A non-conductor, whether charged or not, is without effect. The effect of a conductor increases with its size or capacity, and with its proximity to the tube, until the fullest effect (viz., that given by an earth connexion) is produced. That the effects are not due to electro-dynamic, or to magnetic action, is shown by the fact that a coil of wire produces the same result, whether the ends be joined or not. The effects of an iron core and helix with open ends are often comparable with, and sometimes equal to, those when the ends, being connected with a battery, the whole becomes an electro-magnet. The effect upon the interior is, in fact, due to the relief given by the conductor to the electric tension on the outer surface of the tube and the space around it, caused by the individual discharges.

Instead, however, of connecting a point (P) on the tube with a large conductor or with earth, we may connect it with one or other terminal of the tube. And a further study of the subject shows that all the phenomena due to action from without may be produced by means of one or other of these connexions. Connexion with the non-air-spark terminal gives the relief effects described above; connexion with the air-spark terminal gives another set of effects. Of these the feeblest has the appearance of attraction, while the strongest shows an abrupt termination of the positive column in the neighbourhood of the point (P), followed by a negative halo, and then by a recommencement of the positive column in the direction of the negative terminal. Each of these sectional discharges is in fact independent and complete in itself, and they are due to impulses of positive electricity thrown into the tube from the air-spark. At the positive terminal these impulses are thrown directly in; at the points of connexion they are due to induction, *ab extra*. The negative part of what was originally neutral meets the positive column, and satisfies it as it arrives, while the positive leaps forward to meet the negative due from the negative terminal.

The effects above described need not be confined to a single patch or ring of conducting material placed upon the tube; but they may be produced many times over in the same tube by a series of rings arranged at suitable distances. By this means the column may be broken into a series of sections, all terminating with well-defined configurations towards the negative end, and having greater or less length, according to the position of the rings. In the paper itself, arguments are there brought forward showing that these sectional discharges represent striæ not merely in their appearance, but also in their function and structure. But the discussion could hardly be produced within the limits of an abstract.

Returning from the digression about striæ, the authors next give evidence, derived mainly from the revolving mirror, and from the discharges of a partially charged Leyden jar, for the following conclusion: That the passage of the discharge occupies a time sufficiently short in comparison with the interval between the discharges to prevent any interference between successive pulses. Certain experiments are then described which indicate that the discharge is effected, under ordinary circumstances, by the passage through the tube from the air-spark terminal of free electricity, of the same name as the electricity at that terminal. In the case of an induction coil, where the air-spark must be considered as existing at both terminals, there is evidence of a *neutral zone*, where the sensitiveness disappears. The position of this zone may be altered by damping the impulses at either terminal; or it may be abolished by connecting one terminal with earth. The impulses may even be so distributed as to divide electrically a single tube into three sections, the two extremes presenting visible discharges, with a dark section between them.

Looking at all these phenomena from an opposite point of view, we may, by means of the relief effects, determine the terminal from which a discharge proceeds, and the distance to which it reaches without provoking a response from the other. And through these considerations, together with others detailed in the paper, the authors are led to the conclusion that the discharges at the two terminals of a tube are in the main independent, and that they are each determined primarily by the conditions at their own terminal, and only in a secondary degree by those at the opposite terminal.

In illustration of this view, an account is then given of the production of unipolar, positive, or negative discharges in a tube. In such cases, the discharge being insufficient of itself to pass through the tube, returns by the way by which it entered.

This closes a series of experiments, the result of which is that the discharges from the two terminals can be made of equal intensity, or of any required degree of inequality; or the discharge can be made to issue from one terminal only, the other acting only receptively; or it can be made to return into its own terminal, while the other takes no part in the discharge; or, finally, the two terminals can be made to pour out independent discharges of the same name, each of which returns to its own terminal.

Having traced the relation between the two parts of the discharge, and having found means for controlling their range and influence, the authors were led to inquire whether there be any experimental evidence of the state of the tube during the occurrence of the discharge. Some experiments with two pieces of

tinfoil of unequal size placed near the ends of the tube and metallically connected, and others with a strip of tinfoil placed along the tube, all gave effects showing that the discharge cannot be simultaneous throughout the tube. The phenomena appear to require for their interpretation that, in front of the pulse coming from the (positive) air-spark terminal, there is, during the interval between the pulses, a rising negative potential. This is entirely swept out by the pulse as it advances along the tube, after which the process is repeated. The condition of things behind the pulse is more difficult to determine, but an experiment with the telephone gives reason to think that parts of the tube nearer to the non-air-spark end are in a condition to demand relief, before those nearer to the air-spark terminal have ceased to require it. And on this account the discharge may, perhaps, be more nearly represented by a lazy tongs than by a bullet.

How far the results obtained from the sensitive state are applicable to ordinary discharges is a question which cannot yet be definitively answered. But the marked similarities in the phenomena, and the predisposing circumstances of striation or non-striation, as well as in the terminal peculiarities of the two kinds of discharge, point strongly to the conclusions that all vacuum discharges are disruptive; and that sensitive differ from non-sensitive discharges mainly in the scale of the discontinuity due to the disruptiveness, causing a difference between the two classes of phenomena analogous to that between impulsive and continuous forces in dynamics.

Mathematical Society, May 8.—Mr. C. W. Merrifield, F.R.S., president, in the chair.—Messrs. A. J. C. Allen and E. Anthony were elected Members.—The following communications were made:—On the complex whose lines join conjugate points of two correlative planes, Dr. Hirst, F.R.S.—Note on a geometrical theorem connected with the function of an imaginary variable, Prof. Cayley, F.R.S.—Some definite integrals, the late Prof. Clifford, F.R.S.—A method of constructing, by pure analysis, functions X, Y, &c., which possess the property that $\int X\,Y\,d\sigma = 0$, and such that any given function can be expanded in the form $\alpha X + \beta Y + \gamma Z + \ldots$, Mr. E. J. Routh, F.R.S.—The numerical calculation of a class of determinants, and a continued fraction, Mr. J. D. H. Dickson.—On the inscription of the regular heptagon, Rev. Dr. Freeth.

Zoological Society, May 6.—Prof. W. H. Flower, F.R.S., president, in the chair. A letter was read from Mr. E. L. Layard, F.Z.S., relating to the localities of certain species of Fruit-Pigeons (*Ptilopus*) of the South Pacific Islands.—Prof. Flower, F.R.S., exhibited and made remarks on a drawing of a British Cetacean (*Delphinus tursio*), taken from a specimen captured near Holyhead in 1878.—A communication was read from Mr. Gerard Krefft, giving the description of a supposed new form of insectivorous Bat, of which a specimen had been obtained on the Wilson River, Central Queensland.—The Rev. Canon Tristram, C.M.Z.S., read a description of a new species of Wood-pecker, from the Island of Tyzu Sima, near Japan, which he proposed to name after its discoverer, *Dryocopus richardsi*.—A communication was read from Mr. F. Moore, F.Z.S., containing the descriptions of new genera and species of Asiatic Lepidoptera Heterocera. Eleven new genera were characterised and ninety new species described.—Mr. G. French Angas, C.M.Z.S., read the descriptions of ten new species of shells of the genera *Axinæa* and *Pectunculus*.—A communication was read from Mr. W. A. Forbes, F.Z.S., on the anatomy of the African Elephant, based on the facts observed during a dissection of a young female of that species during the last winter. The structures of the thoracic, alimentary, and urino-genital viscera of this species were described, and compared with the previously published accounts of those of both the Indian and African species of Elephant. The most important differences observed were those displayed in the liver and female organs, but on the whole were not of such a nature as to make it advisable, in the author's opinion, to separate *Loxodon* as a genus from *Elephas* proper.—A paper was read by Mr. F. Jeffrey Bell, F.Z.S., on the question of the number of anal plates in the Echinoderms of the genus *Echinocidaris*.

Geological Society, April 30.—Henry Clifton Sorby, F.R.S., president, in the chair.—Alfred Stanley Foord was elected a Fellow of the Society.—The following communications were read:—A contribution to the history of mineral veins, by John Arthur Phillips, F.G.S. In this paper the author described the phenomena of the deposition of minerals from the water and steam of hot springs, as illustrated in the Californian region, referring especially to a great "sulphur bank" in Lake County, to the steamboat springs in the State of Nevada, and to the great Comstock lode. He noticed the formation of deposits of silica, both amorphous and crystalline, inclosing other minerals, especially cinnabar and gold, and in some cases forming true mineral veins. The crystalline silica formed contains liquid-cavities, and exhibits the usual characteristics of ordinary quartz. In the great Comstock lode, which is worked for gold and silver, the mines have now reached a considerable depth, some as much as 2,660 feet. The water in these mines was always at a rather high temperature, but now in the deepest mines it issues at a temperature of 157° Fahr. It is estimated that at least 4,200,000 tons of water are now annually pumped from the workings; and the author discussed the probable source of this heat, which he was inclined to regard as a last trace of volcanic activity.—*Vectisaurus valdensis*, a new Wealden Dinosaur, by J. W. Hulke, F.R.S. The characters presented by the genus *Vectisaurus* were stated to be as follows:—Ilium with a long compressed ant-acetabular process, having its greatest transverse extent in a vertical plane, and strengthened by a strong ridge produced from the sacral crest. Vertebræ in anterior dorsal region having opisthocœlous centres, their lateral surfaces longitudinally concave, transversely gently convex, meeting below in a blunt keel.—On the Cudgegong diamond-field, N.S.W., by Mr. Norman Taylor.—On the occurrence of the genus *Dithyrocaris* in the lower carboniferous, or calciferous sandstone series of Scotland, and on that of a second species of *Anthrapalæmon* in these beds, by R. Etheridge, Jun., F.G.S.

Cambridge

Philosophical Society, May 5.—A communication was made to the Society by Prof. T. McK. Hughes, on the relation of the appearances of life upon the earth to the known breaks in the continuity of the older sedimentary rocks. In his introductory remarks the author explained the manner in which he believed the transference of the area of the growth of sediment took place by gradual depression on one side and elevation on the other, and pointed out that there was stratigraphical evidence of the earlier commencement of the accumulation of a continuous series in one area than another, and that often the direction of the movements could be inferred. To the compulsory migration of species consequent upon these movements he attributed the extinction of those that could not adapt themselves to the new circumstances, the appearance of the colonies described by Barrande, and also the gradual introduction of new forms of life throughout the whole of the sedimentary rocks. The principal part of the paper was upon the last question, the author holding that it was only reasoning in a circle to define formations palæontologically and then to speak of the incoming and outgoing of species as nearly coincident with the beginning and end of the formation. He classified the whole sedimentary series on the principle of grouping together all the sediment continuously deposited in any one area, and indicated by corresponding intervals the period during which there was in that area denudation only, the deposition of the denuded material necessarily going on elsewhere. Then, giving an analysis of the palæontology of the older rocks, he showed that the various forms of life came in gradually as compelled to move, and as their travelling powers allowed them, from adjoining areas where local conditions had become unfavourable, pointing out that they did not generally first appear at the beginning or disappear at the close of any series of continuous deposits, but that new forms kept turning up all through, and that after a long interval, whether measured by denudation or deposition, about the same kind and amount of palæontological change had occurred, the chances being that in so long a time geographical changes had taken place in the surrounding district. He showed that thus the palæontological confirmed the stratigraphical evidence with regard to the persistence of continental as well as of oceanic areas, as the sequence of life on the earth required that there could never have been an interruption in the continuity of suitable land and water. He appealed to physicists to tell us whether chiefly to the transference of such great masses of material always to the coast lines of continents, or to secular cosmical action, or to both, we should refer this persistent creeping of earth folds in various directions at different times.

Paris

Academy of Sciences, April 28.—M. Daubrée in the chair.—The following papers were read:—On the electric light,

by M. Jamin (see last week's NATURE).—On criticism of experiments undertaken to determine the direction of the pressure in oblique arches, by M. de la Gournerie.—On the choice of moduli in hyperelliptic integrals, by M. Borchardt.—The president of the Venus Transit Committee presented fascicle B of "Documents relating to Measurement of Photographic Negatives." This includes a thorough discussion of the measurements at St. Paul's Island.—Report on a note relative to the embankment of the Tiber at Rome, presented by M. Dausse. Instead of trying to obviate inundations by high quay walls, this engineer recommends a partly natural deepening of the bed, securing continuous navigation. He bases his arguments on results of a system adopted on the Po and elsewhere, in which the river is narrowed by submersible dykes (within insubmersible ones), and by its thus increased velocity insures a sufficient draught of water. In flood-time the water-level is lower than formerly, and the expanded river gives rich deposits in the larger bed beyond the submersible dykes.—On the electrical inscription of speech, by M. Boudet de Paris. A very sensitive microphonic transmitter is used, in which the carbons are simply held in contact by a small piece of paper folded in the form of V. The receiving telephone has diaphragm and cover removed, a spring fixed at one end on the wood, and at the other end (to which is added a small piece of soft iron), resting on the magnet; a light bamboo style with whalebone extremity is attached to the spring, and gives instructive traces on decalcomanic paper.—Observation of the periodic comet II., 1867 (Tempel), made by M. Tempel at Florence Observatory.—On a new form of co-ordinates in the problem of two bodies, by M. Gyldén.—On a class of non-uniform functions, by M. Picard.—Theoretical and experimental demonstration of the following definition of temperature: Temperature is represented by the length of calorific oscillation of the molecules of a substance, by M. Pictet. He verifies these two laws: 1. The higher the points of fusion, the shorter are the molecular oscillations. 2. The temperatures of fusion of solids corresponding to equal lengths of oscillation, and the product of the lengths of oscillation by the temperatures of fusion, should be a constant number for all solids.—Siren with electromagnetic regulator, by M. Bourbouze. An improvement on an apparatus described December 18, 1876; with a pinion and double rack he can simultaneously bring near both electromagnets to the copper disk or remove them, obtaining any note in the siren.—On a mode of continuous registration of the direction of the wind, by M. André. This instrument, constructed by M. Redier, is used at Lyons Observatory.—On the present state of Vesuvius, by M. Semmola. The large crater of 1872 is almost wholly filled up; the new cone of eruption has grown so that it is now on a level with the old crater, and will soon be above it. Lavas are sometimes poured out on the north side, and seen from Naples. Fumeroles of lava are very frequent and lively on the interior walls of the old crater; they are all acid. (The products, &c., are described.)—On the laws of dissociation, by MM. Moitessier and Engel. From experiments with hydrate of chloral they find (*inter alia*) that the dissociation of a substance whose two components are volatile takes place even in presence of one of the products of the dissociation, so long as the tension of this product does not exceed that of dissociation of the substance at the temperature operated with.—On the determination of glucose in the blood, by M. Cazeneuve.—Facts bearing on the history of beer yeast and alcoholic fermentation; physical and physiological action of some saline substances on normal yeast, by M. Bechamp. The action of acetate of soda is specially studied.—On the form of muscular contraction of the muscles of the crayfish, by M. Richet. Between the principal muscles, that of the tail and that of the claw, there is as considerable a difference as between smooth and striated muscles in vertebrates.—The cochineals of the young elm, a new genus, *Ritsemia pupifera*, by M. Lichtenstein.—Why one sometimes finds plants of limestone associated with those of silica, by M. Contejean.

May 5.—M. Daubrée in the chair.—The following papers were read:—On the heat of formation of cyanogen, by M. Berthelot. Cyanogen (like acetylene and bioxide of nitrogen) is a substance formed with absorption of heat. The mean number, 132·3 cal., was obtained for its heat of combustion (the equivalent (C_2N = 26 grammes); this number is somewhat less than Dulong's.—On some derivatives of durol (α-tetramethylbenzine), by MM. Friedel, Crafts, and Ador.—Experiments for determining the direction of the pressure in a slanting arch, by M. de la Gournerie.—On the transformations of the second order of hyperelliptic functions, which, applied twice successively produce duplication, by M. Borchardt.—On the crystals extracted from cast iron by ether or petroleum, by Prof. Lawrence Smith. The cast iron is treated in a finely divided state. It yields a soluble matter consisting chiefly of sulphur, and crystallising in fine needles, like the matter which the author has separated from meteoritic graphite. M. Berthelot stated he had got like crystals by treating artificial or natural sulphides with ether or alcohol, and he attributed the matter to chemical action of the sulphur on the hydrocarbonised solvent. The results inspire reserve in conclusions as to pre-existence, in meteorites, of those crystallisable hydrocarbonised matters which are capable of extraction by organic solvents.—M. Daubrée presented a memoir by M. Abich, on the production and geotechnic conditions of the naphtha region near the Caspian.—Mr. MacCormick was elected correspondent for the section of Rural Economy, in room of the late M. Chevandier de Valdrôme.—Reflex effects produced by excitation of the sensitive fibres of the pneumogastric and the superior laryngeal on the heart and vessels, by M. François-Franck. The effects are moderation of the heart's action conjointly with constriction of the vessels.—Effects of sulphide of carbon on the radicular system of the vine, by M. Boiteau. He points out certain evils connected with this mode of treatment. The sulphide destroys organic substances which are in its most concentrated atmosphere. Injections should be made 30 or 35 ctm. from the stem, and combined so that there should be two (of 10 grammes) per square metre.—Geometrical determination of umbilici of the surface of the wave, by M. Mannheim.—On the equivalence of algebraic forms, by M. Jordan.—On the calculation of perturbations, by M. De Gasparis.—On a theorem of dynamics, by M. Siacci.—On the thermal formation of siliciated hydrogen, by M. Ogier. He tried to determine the heat of combustion by means of free oxygen; whence he finds the union of $Si + H_4$ to be accompanied by a liberation of heat = + 24·8 cal., which is near the heat of formation of marsh gas (+ 22 cal.).—On the limit of separation of alcohol and water by distillation, by M. Le Bel. Ninety-seven per cent. was attained.—On a new isomer of angelic acid, by M. Duvillier.—Transformation of camphic acid into camphor, by M. De Montgolfier.—On the contractility of blood-capillaries, by M. Rouget. In all vertebrates a contractile coat of the same type, modified only in the number of its elements, envelopes the whole system of vascular blood-canals, including the heart and the capillaries. Contractility (modified only according to region) is an essential property of all the system.—On the action of salts of strychnine on gasteropod molluscs, by M. Heckel. These animals show a remarkable immunity as regards salts of strychnine. As in vertebrates, the degree of injuriousness of the poison is in inverse ratio of the animal's weight. The toxical phenomena are of the same order as in higher animals, *i.e.*, strychnine is a poison of the nervous system (tetanising).—On the *Haptophrya gigantea*, a new opaline of the intestine of anouran Batrachians in Algeria, by M. Maupas.—Artificial reproduction of native carburetted iron of Greenland, by M. Meunier.

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